A FINANCIAL AND SOCIAL ANALYSIS OF FORESTRY PLANTATIONS IN THE NORTHERN DISTRICT OF PAPUA NEW GUINEA

BY

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FORWORD

My interest in the subject of forestry plantation planning was first stimulated by a period of employment with the Lao-Australian Reafforestation Project. This interest was further developed by a period of employment with the Papua New Guinea Department of Forests in 1974, which enabled me to experience at first hand conditions in the Northern District of Papua New Guinea. A Commonwealth Post Graduate Award enabled me to return to the Australian National University and prepare for this essay.

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Geoffrey Hodges.

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CHAPTER 1

INTRODUCTION

The rapid increase over recent years in the rate of harvesting of tropical rainforest has raised fears that the developing countries of the tropics may follow the pattern of some developed countries, who harvested their forests without replanting, and later faced a resource deficit. Partly as a consequence of this many tropical countries have begun to establish forestry plantation to replace the forests being harvested.

Planning of these forestry plantations is often far from optimal. Planners frequently approach the problem in the same way as in the developed countries. In many cases this is not appropriate. The social and economic milieu is not the same, and unlike most developed countries the social and political conditions are often changing rapidly. There is a need to consider a far wider range of factors in the planning process.

Moreover in some cases plantations are being established without adequate knowledge of the likely benefits and costs. In other cases valuable opportunities for the establishment of forestry plantations are being missed. There is clearly a need for the wider dissemination and application of appropriate methodology for analysing projects.

This essay demonstrates an approach to the planning and analyses of plantations in the Northern District of Papua New Guinea, however the aim is to show a methodology which may also be applied in similar localities elsewhere.

Papua New Guinea consists of the Eastern half of New Guinea and the Bismarck Archipeligo, Bougainville Island in the North Solomons, and several groups of smaller Islands. The land area is small (approximately twice the size of Victoria) but extremely rugged. The mainland is characterized by a broad range of high mountains forming an east-west spine, with further large ranges to the north and north-west. These ranges rise to over 5,000m in places and enclose many upland valleys. The mountains also form the watersheds of great rivers which flood across the lowland planes to the south, north, and east. With the exception of the Fly and Sepik Rivers whose lower reaches are swamp, the rivers can only be navigated for short distances, and they act as effective barriers to lateral movement along the coastal plains The major islands have a topography which is similarly rugged and difficult of access. Many of the lowland areas are heavily forested with tropical evergreen rainforest.

The Northern District is characteristic of Papua New Guinea and many other areas of the tropics. It is heavily forested with tropical rainforest. Moreover the social and economic conditions are those often found in the developing countries. Incomes are low, and there is relatively little employment in the modern sector. The social and economic conditions and the forest resources of the District are relatively well documented, and the district is isolated by mountains, and forms an identifiable economic unit. Therefore it seems to be an appropriate and relatively easy location in which to perform a model study.

The factors which will largely determine the course of forestry development in the Northern District are Government policy, social and economic conditions, and the pattern of forest resources. These factors are examined in Chapters 2 to 4. A likely forestry development which includes a plantation project is outlined in Chapter 5. The plantation project plan is considered in Chapter 5 and 6 and presented in Chapter 7. The financial and social analyses are in Chapters 8 to 11.

The study is intended to provide a model to illustrate an approach to planning a forestry plantation project in a developing country. While every effort has been made to obtain the best available data reliable data was not always available and estimates had to be made in some cases. These estimates are identified in the text. In some cases these estimates have a considerable bearing on the results of the evaluation of the project and this should be born in mind when interpreting the results. The most influential of these estimates are noted in the conclusions.

Constant prices as at December 1976 are used throughout unless otherwise stated. Common names are used for tropical forest species throughout this essay. In Papua New Guinea these common names are frequently the generic names. They occasionally include both generic and specific names.

CHAPTER 2

GOVERNMENT POLICY

An understanding of government policy and its development is an essential pre-requisite to the evaluation of a development project. Present policy determines essential aspects of the environment in which the project will take place. Past changes in policy often reflect economic and social developments and may suggest the direction policy is likely to take in the future.

2.1 THE TERRITORY OF PAPUA AND NEW GUINEA IN 1964.

2.1.1 Demography of Papua New Guinea.

At the time of the World Bank mission there were approximately 2 million people in the Territory. The vast majority of the population lived in rural areas with a low population density averaging 11 per square mile. Most of these people practised subsistence agriculture. Less than 2.5% of the population (50,000 people) lived in towns. Only 4% (80,000) of the population were employed in the modern sector, mainly on plantations, and 30% of these were indentured labourers who returned to their villages on completion of their contracts (I.B.R.D., 1964). Speaking in general terms the indigenous people were reasonably well off in comparison with people in other developing countries, because of the benign climate and a relative abundance of food

and water. There were some serious problems in the villages at the time, mainly relating to health. Population growth was running at 2.3% per annum, mainly as a result of successful controls on tribal fighting and the provision of some health services. This population growth had lead to serious overcrowding in parts of the Eastern Highlands and in East New Britain.

2.1.2 Formal Institutions.

The Administration consisted of 16 Departments, and there were 15 Administrative Districts each with a District Commissioner who was responsible for co-ordination. This administration was highly centralized however and most decisions of any consequence were made in Port Moresby. The most important decisions were made by the executive authority, the "Administrator", who had the status of the head of a government department in the Australian Public Service, and was responsible to a minister in Canberra. This organisation dated from the Papua New Guinea Act of 1949.

Local government Councils were initiated in the early 1950's as part of the effort to extend local organization beyond individual villages. By 1964 there were 77 councils scattered over the country, encompassing approximately one third of the population. Councils levied head taxes and were involved in the provision of a variety of services under the control and direction of the Administration. There was increasing indigenous participation in the Public Services, with 127 indigenes already in the second or third division, and with another 900 in training in the auxill ary division. The House of Assembly with a majority of

elected members had been organized to replace the Administrator's Advisory Council established in 1961, and it contained indigenous members (I.B.R.D., 1964). Nevertheless at the time there was little if any feeling of national identity, and no political parties. Moreover language, geographic and educational barriers promised to make it difficult for local leaders to emerge from the bonds of custom family and area attachment.

A truly indigenous political structure of any scope had never existed in the territory. Hereditary chiefs were unknown. The only supra-tribal organizations were those that had been established and staffed by expatriate administrations (I.B.R.D., 1964).

2.1.3 Modern Sector.

In 1964 the monetary sector was very small with a Gross National Product of the monetary sector of Kina 110 million at factor cost, Government activities dominated this sector with total expenditures of K70 million.

Fully 30% of these expenditures were invested, although much went to non-productive assets. For example 55% of government investment went to housing, hospitals, and schools, most of it to serve the rapidly expanding expatriate population, and 28% to administrative services, and law and order. Only 30% of investment went to basic infrastructure such as roads, telecommunications and the like, including 6% to services for agriculture and forestry. In short, expenditure was geared to the provision of a basic administration for indigenes and the provision of modern services of all kinds for the expanding population of expatriates.

This expensive administration was largely maintained by the Australian Government with direct grants of K40 million, and direct expenditures by Australian Government of a further K10 million. Only K18 million was raised locally, and this came mainly from customs duties, direct taxes, and charges on expatriates consumption and production. Additional support was provided to the Territory by the Australian Government through preferential treatment of Territory exports, and Australia absorbed fully 50% of Territory exports at the time.

The private sector was dominated by plantation agriculture most of which was owned and managed by expatriates, and a rapidly expanding construction industry which benefited from the expenditures on facilities for expatriates. The manufacturing industry produced only 10% of monetary sector Gross National Product. The Timber industry was very small and was geared entirely to the local market.

Investment by private enterprize in 1964 was estimated to be K16 million and almost all of this was reinvestment of profit by Australian, Malay, and Canadian interests. Investment from overseas had fallen in the late 1950's as a result of the Government's statement of its intention to move towards indigenization of the economy.

The balance of payments was dominated by Australian Government grants and expenditures, and by exports of primary products, mainly copra (45%), cocoa (18%), coffee (12%) and rubber (7%) to a value of K16 million. Most income went directly to expatriates, either through salaries, public services, or as

payments for agricultural production. Capital outflows were dominated by payments for imports of western goods, mainly for expatriate consumption, and by transfers of funds by expatriates, mainly to Australia, and these capital outflows were estimated to be running at K3m to K5m (I.B.R.D, 1964).

Indigenous participation in the monetary sector was small, but considerable numbers were employed in the plantation areas as servants, or as labour on construction projects in the towns. Indigenous wages were small, being about one twelth the average expatriate wage for unskilled workers. Wages were often paid mainly in the form of expensive imported items such as rice or clothing. Indigenes did participate to some extent in the production of agricultural products, and they produced perhaps one third of this category of export in 1964, however their returns were unreliable, with large numbers engaged in a small way, and hence there was little saving of cash, and almost no investment by these people. At the time no institutions were provided from which indigenes could obtain loan funds (I.B.R.D., 1965).

2.2 GOVERNMENT POLICY FROM 1964 TO THE TIME OF INDEPENDANCE, DECEMBER 1974.

The World Bank mission of 1964 proved to be a catalyst for the formulation of new policy. Following the mission the Government drew up a policy which placed heavy emphasis on both development and indigenization. The major emphasis was placed on a rapid development of productive economic activity. At the

time the largest and most productive sector of the economy was expatriate plantation agriculture, and a substantial effort was made to provide encouragement to this sector of the economy. At the same time efforts were made to increase indigenous participation in the institutions under direct control of the administration, the public service, and the political apparatus at the national, district, and local government levels. Educational facilities were expanded, particularly at the secondary school level, as were health and administrative services in rural areas.

A new five-year plan was announced in 1968 (P.N.G. Administrator, 1968), but policies were not changed; development and indigenization remaining the major objectives. The Administration did however decide to give greater encouragement to overseas investment, particularly in those areas such as agriculture and mining which had great export potential. The policy on welfare continued with little change. Some efforts were made to attract investment in small scale manufacturing industry to provide more employment in towns, and increased efforts were planned to expand the rate of indigenization of the public services.

One project during the period had an enormous impact on the economy of the Territory and is mentioned in some detail to illustrate the sort of effects that large scale projects may have on the Papua New Guinea economy today. The Bougainville Copper Mine of Bougainville Lmt. transformed the local and national economy from the onset of the construction phase in 1969. The Gross National Product of the monetary sector is estimated to have risen 29.1% that year, largely as a result of the mine ope-

ration, The share of expenditures originating in the public sector fell substantially, and private domestic savings rose from K36.8m to K84.7m (P.N.G. Office of Progamming and Co-ordination, 1971).

However investors lost interest in other sectors of the economy, Overseas investment in agriculture, forestry and fishing declined from K3.3m. to K0.5m , and there was little increase in investment in the manufacturing sector. Furthermore as the mine neared completion in 1970-71 expenditures on wages fell precipitously. The Government was forced to substantially increase public investment projects, Government expenditures being increased to 40% of Gross National Expenditure. Nevertheless Gross National Product fell K20.7m in 1971-72. When the mine opened in 1972, the Gross National Product in the monetary sector quickly recovered to exceed the 1970-71 level.

The balance of payments position also fluctuated markedly during the period. In the construction phase wealth flowed into the country as a very large quantity of capital imports were financed mainly from abroad, but when the mine opened the flow of wealth was reversed, and thus although exports rose from K93.4m in 1971-72 to K229.1m. in 1972-73, most of the factor payments went to overseas investors. Similar fluctuations occured in the balance of trade.

Furthermore, local population movements and employment fluctuations destabilized parts of the society. Early in the construction phase 11,000 unskilled workers were recruited from all parts of the territory. Considerable friction developed between these migrant workers and the local people at the cons-

truction site. As the project neared completion, large numbers of workers were released. Most had little alternative but to move to squatter settlement in the towns, or return to their village. This migration spread dissatisfaction throughout the Territory.

It seems that the two objectives of development and indigenization remained the central planks of policy from 1964, until self government on December 1st 1973. First attempts to implement the development policy were cautious, but as the difficulties of attaining development become apparent the Administration become more single minded in its approach. Efforts to indigenize the economy were largely limited to the public sector until well into the 1970's. Welfare remained a secondary consideration.

2.3 ECONOMIC AND INSTITUTIONAL CHANGES BY INDEPENDANCE.

2.3.1 Modern Sector in 1973.

Gross National Product in the monetary sector was K502m in 1972-73, the growth rate had averaged 14% in real terms during the previous 5 years, and the private sector was very greatly expanded. Table 2.1 shows the estimated outputs, and the average growth rates during the previous 5 years of the major industries.

Table 2.1 OUTPUT OF INDUSTRIES 1972-73.

Industry	Estimated Output (million Kina)	Annual growth rate %
Agriculture/pastoral	57.4	3.4
Marine products	6.3	50
Forestry	19.4	12.9
Mining	176.8	50
Manufacturing	96.4	10.5
Tourist	15.0	15

Source : P.N.G. Central Planning Office, 1973).

Table 2.1 shows that the mining sector dominated the economy, largely due to the Bougainville Copper mine. Manufacturing was substantial and the industry was growing despite relatively unstable conditions. Forestry was also growing largely as a result of the production and export of logs. Agricultural production remained very important, but growth had almost ceased.

By 1973 the public sector had declined in relative importance as a result of the rapid expansion in the private sector. This was in spite of substantial increases in public spending and capital formation, which were K130.8m and K79.7m respectively in 1971-72.

The balance of payments had changed considerably. There was a surplus for the first time in 1972-73. Moreover this was accompanied by a net factor income to the rest of the world of K112.5m. (because recent investment had largely been financed from abroad), and the economy remained dependant on Australian

Grants in Aid.

The total monetary sector work force had increased to 322,000 and this included one in every five indigenes of working age. However these indigenes were not spread uniformly through the workforce. Table 2.2 shows their respresentation in different employment categories.

Table 2.2 REPRESENTATION OF INDIGENES IN THE MONETARY SECTOR WORKFORCE IN 1974.

Manpower class	Indigenes %
Professional	13.6
Subprofessional	49.8
Skilled	70.6
Semi-skilled	97.8
Unskilled	100.0

Source : P.N.G. Central Planning Office, 1973.

Table 2.2 shows that the vast majority of indigenes were employed in the semi-skilled and unskilled categories of the workforce. They remained poorly represented in the much smaller professional and subprofessional groups.

At this time more than 50% of the workforce were engaged in rural employment, and most of these people were self-employed and received small and unreliable returns from cash cropping activities. Wage employment was concentrated around the major towns, and especially around Port Moresby, Lae, and

Rabaul, but only a small elite group had penetrated the higher levels of government, and to a smaller extent, commerce and manufacturing. The indigenous share of disposable income had actually fallen from 40% in 1961, to 34.4% by 1970 (P.N.G. Central Planning Office, 1973).

2.3.2 Institutional Change.

Institutions based on the Westminster system of government had been developed from the old House of Assembly. Final authority on most matters was exercised by a cabinet selected from the members of the majority coalition party in the House. The Administrator's role had been largely reduced to that of an advisor. Furthermore the public service had been modified to face the more pressing needs. Educational institutions had been created to train skilled workers, and the planning services available to government had been strengthened. There had also been major developments in the financial sector, with the formation of the Investment Corporation of Papua New Guinea and the Papua New Guinea Banking Corporation, which were designed to facilitate indigenous savings and investment.

2.4 ECONOMIC AND SOCIAL PROBLEMS.

The policy of development succeeded in its objective, but generated a legacy of instability and economic and social problems for the incoming indigenous government. Several of these problems had reached serious proportions by 1973.

The concept of equality occupies a central position in indigenous culture but the pursuit of economic growth had led to gross inequalities between rural and urban areas, between localities and regions, and between occupations. These inequalities were destabilizing and politically dangerous.

Moreover indigenous ownership was very limited. Under the policy of rapid development large quantities of capital were needed and were provided by expatriate interests. Moreover these funds went increasingly to resource exploitation where quick profits were made, which were often subsequently reinvested in further profitable schemes. Hence the expatriate capital base grew rapidly, but in general indigenous people did not aquire capital. It became clear that if indigenes were to participate more equitably in private enterprize, there would have to be direct assistance to them, and fundamental changes to the legal and institutional apparatus.

Furthermore Government control of the economy had diminished during the period of rapid development. Dependance on overseas private investment funds had increased. The tax base remained largely expatriate and very subject to outflows of investment funds when investment confidence fell. Moreover the economy depended on exports of minerals and other primary products whose prices are notoriously volatile.

By independance, welfare problems were causing instability in many areas. Development had attracted very large numbers of people to the towns, many of whom exchanged material and social poverty for their previous materially and socially adequate lifestyle. Large squatter settlements grew up around the towns and

some estimates of squatter numbers are shown in Table 2.3.

Table 2.3 SQUATTER SETTLERS 1972.

Centre	Number of sqatters	Growth rate 1969-72 (%)
Port Moresby	15,820	43.8
Rabaul	2,600	44.4
Lae	21,250	44.2
Madang	4,100	12.3
Mt Hagen	5,500	51.7
Wewak	5,000	51.5
Goroka	500	41.9
Popondetta	3,000	51.1

Source : P.N.G. Central Planning Office, 1973.

Table 2.3 shows the magnitude of the problem, particularly at the main centres of Port Moresby and Lae, and its widespread nature. Even Popondetta in the Northern District had 3,000 squatters in 1972, amounting to 2/3 rd's of the town population.

The Government had been able to devote more funds to welfare as production in the private sector increased. By 1972 57.7% of Government income was spent by the "social" departments such as education and health. Nevertheless the general level of welfare declined in many areas. The money spent was spread more thinly because the population had increased to 2.5m by 1971, and much of the money now went in efforts to ameliorate conditions in the towns. These efforts were not adequate to keep pace with

the rate of urban population growth which was 12.5% from 1967 to 1972. Housing became scarce. The number of dwellings completed each year actually falling at an average rate of 6.7% between 1967 and 1972. Transport facilities declined during the period with the number of buses per 100,000 people falling from 36 to 29. At the same time the number of unemployed in towns rose dramatically in spite of a considerable increase in the number of employment opportunities. These trends continued beyond independance.

The result was increasing instability in the towns. Reported crimes per 1,000 population rose from 9.3 in 1969 to 14.5 in 1971, a rate of growth of 26%, the juvenile delinquency rate rose from 6.5 in 1968 to 9.3 in 1975. Both rates increased further towards the time of independance.

Furthermore although some rural areas were insulated from the destabilizing influence of development, serious problems developed in many others. Many villages were becoming overcrowded, and there were many young people who had received some education but were now idle. This group provided a fertile ground for trouble-making by ambitious politicians, or by disgruntled workers displaced by the rapid changes of direction of the economy at some particular locality.

These problems were to play a large part in shaping the policies of the nation after self government.

2.5 POLICIES UNDER AN INDIGENOUS GOVERNMENT.

2.5.1 The Eight Point Plan.

The Government at the time of independance took the opportunity to draw up a new plan (P.N.G. Central Planning Office, 1973). This was based on eight fundamental propositions.

1. The proportion of Papua New Guinean control of and benefit from the economy should be increased.

2. Economic benefits should be more equitably distributed, by movement toward equalization of incomes and services for various groups in different districts and areas.

3. Economic activity and planning should be decentralized by directing Government spending to area and local authorities, and particularly to the development of agriculture, village industry, and internal trade.

4. Small scale artisan and business activity, particularly those which are typical of Papua New Guinea should be given special encouragement.

5. The economy should be made more self reliant by local production of a greater proportion of the people needs.

6. The capacity of the local economy to provide revenue should be increased.

7. The equal and active participation of women in all forms of social and economic activity is desirable and should be encouraged.

8. The Government should exercise sufficient control to ensure development is of the kind desired.

These propositions have provided the basic framework

for subsequent policy.

2.5.2 Government Policy of 1973-74.

The policy of the one year plan of 1973-74 (P.N.G. Central Planning Office, 1973) gave priority to the spread of benefits of development to all the people. The major measure proposed was a redirection of spending on assistance to small scale enterprize in the rural areas, and the development of new projects in neglected areas. Expenditure on urban areas was to be reduced in proportion. It was also proposed to modify legislation to make it easier for indigenes to establish business, and particularly to establish group businesses. Further important proposals were a series of financial measures; the use of prices and incomes policy; purchase of equity in key enterprizes by the Government; and provision of loan funds to assist indigenes to start projects.

To ensure that foreign companies acted in the interests of the Papua New Guinea people these companies were required to transfer equity, skills, and technology to indigenous people under strict schedules. A National Investment Development Agency was established to select and recommend projects that should be developed, and to suggest to what extent the Government or the local people could or should participate. To ensure the necessary investment was forthcoming incentives were to be provided including guaranteed tax holidays, tax deductions, low import duties, and monetary policy to maintain a strong currency.

2.5.3 Government Policy Today.

Recently a Government White paper titled " The National Development Strategy ", was released in Papua New Guinea. This document was the basis for the first long term plan to be formulated by the Indigenous government. Although details are not available, the general tenor of this document was shown in an article in the Australian Financial Review (Oct. 26 1976). The article reports that policy is to continue to place first priority on planning to meet the needs of the rural people directly, and that emphasis will be placed on the development of small scale enterprize based on new technologies suitable to village conditions, whilst still maintaining the economic base provided by subsistance agriculture. A limited number of large scale foreign investments in natural resource based projects are to be developed to provide funds for the rural development strategy, and to replace the large aid component in the budget.

The present leaders who have experience under both the present and former policies have clearly chosen to place general welfare of this generation as first priority, and to accept the lower rate of economic development which may follow. It is essential that these priorities and values be respected in the design and evaluation of any project. That these policies are congruent with the basic values of the rural people will become clear in the next chapter.

CHAPTER 3

THE NORTHERN DISTRICT

3.1 DEMOGRAPHY.

The Northern District embraces an area of 22,000 square kilometres, located between the north-east coast of Papua New Guinea and the Owen Stanley Ranges, stretching from the boundary of the Morobe District in the north to Collingwood Bay in the south-east.

In 1966 there were an estimated 57,967 people in the district at an average population density of 2.9 per square kilometre, approximately half the national average density (T.P.N.G. Department of D.D.A., 1968). The population was not uniformly distributed in rural areas. Along the coastal plains in the vicinity of Popondetta and Ioma, the population density was approximately 5 per square kilometre.

Moving south-west along the road to Kokoda, population densities were higher, averaging 27 per square kilometre along this road and to the south on the slopes of Mount Lamington. Further west over the Kumusi River the population density was approximately 2 per square kilometre. Within localities densities varied considerably. There were as many as 66 per square kilometre on parts of the Mount Lamington slopes (Rimoldi, 1966), whilst in many areas of the coastal plain there were only scattered houses

and some areas of forest were uninhabited. Popondetta, which was the only town of any size, had 1,844 residents.

3.2 SOCIAL ORGANIZATION IN THE RURAL AREA NEAR POPONDETTA.

The people in the Popondetta area, the Orokaiva, have a relatively homogenous culture, and the people speak mutually intelligible dialects of the same language. Nevertheless several distinct groups called tribes may be recognized and these tribes are characterized by having a common territory (Rimoldi, 1966). In most cases these territories are separated by broad belts of forest or grassland which are relatively uninhabited. In others the population has expanded, the forests have been removed, and the boundary between tribes is no longer distinguished in this way. It is believed that among the Orokaiva the tribe was formerly the largest political entity with a group morality. Within the tribe customary law largely restricted any violence to socially sanctioned feuds, whilst between tribes there was continual brutal warfare. On their arrival early in the century, expatriates imposed controls on warfare, and this has now disappeared.

There are several significant divisions within the tribe. The exact definition of these divisions is obscure but Rimoldi (1966) indicated the nature of the common groupings. A clan consists of those individuals who trace their patriliniarity to a common ancestor. A clan may be large but it seldom overlaps tribal membership. Subclans or clan branches are a clan sub-group, the individuals of which are able to organize economic resources in common, and they generally consist of a localized

grouping of the clan. A lineage is a sub-group of the clan branch consisting of near relatives. A kinship group consists of a few closely-related relatives living in close proximity. A household is a group living together and generally consisting of a man, his wife, and his children, with perhaps an immature relative. A hamlet is a small groups of households. A village is a large group of households, or a group of hamlets in close proximity.

In the past most Orokaiva lived in hamlets, which were shifted every few years. Today with the increase in security, there are many isolated households, and some villages which have formed as a result of various external influences, but principally because of population and Government pressures. The nature of the variations in life style from one locality to another are best illustrated by description of societies in two characteristic settings. Inonda is a hamlet which is probably fairly typical of the traditional hamlet. Sevepe is a village which characterizes the residential pattern in more populous areas.

3.3 LIFE STYLES AND LAND RIGHTS.

3.3.1 Inonda Hamlet.

Crocombe and Hogbin (1963) studied Inonda hamlet in some detail. It is located at the foot of Mount Lamington on the east side and a little west of the Oro Bay road. (see Map No. 1(1)). In 1962 the hamlet had 45 residents in 8 households, and these people belonged to 2 lineages of the same subclan. The general area was lightly populated with approximately 5 people per square kilometre, and residents of the nearby hamlets

(1) See Appendix E

belonged to the same subclan.

Table 3.1 shows the distribution of time by activity, for men and women of working age in 1962, based on the work of Crocombe and Hogbin (1963).

Table 3.1 TEMPORAL DISTRIBUTION OF ACTIVITIES OVER A YEAR FOR THE RESIDENTS OF INONDA (days).

	Men	Women
Social obligations	81	83
Paid work	72	-
Subsistence agriculture	74	132
Council and church work	44	46
Cash cropping	6	6
	277	267
Estimate of leisure	88	98

Source : Crocombe and Hogbin (1963).

Table 3.1 shows the substantial amount of leisure time enjoyed by these people. Their active lives were mainly taken up with extensive social obligations and subsistence agriculture. The substantial component of paid work for men reflects the traditional habit of young men leaving the village for several years to earn money to fulfil social obligations.

The Orokaiva therefore probably enjoyed a great deal of leisure time. Moulik (1973) described this state as one of subsistence affluence, and it resulted from the limited demands of the environment for shelter and clothing, and from the abundent

land and excellent conditions for growth, which reduce the time required for agriculture.

Moreover Orokaiva social obligations were extensive and pressing. They included preparation for, and participation in, numerous ceremonies which mark the important events in the life of the individual and of his relatives. There are ceremonies at birth, puberty, marriage, and death, and others which relate to supernatural events.

Most time was spent in subsistence agriculture and the areas used periodically for this purpose can be distinguished by secondary regrowth. Grassland was not used because of the weed problem, and forest land in this area occupied stony land unsuited to agriculture. Plantings were established at all times of the year, and cropping of any particular planting continued for 18 months to 2 years. The fallow period ranged from 10 to 15 years and was selected to minimize the work needed in clearing and weeding. The land does not appear to have been impoverished by this system of agriculture. The average area planted per head per annum at Inonda was 0.11 hectares which implied the need for a total area of agricultural land for this hamlet of 50.8 hectares. The hamlet had far more fertile land than it needed.

Men and women had traditional responsibilities in production, the men doing the heavy work of clearing and fencing; the women doing planting, tending, and harvesting. To an observer the garden plots appeared to be located and moved in a haphazard manner, being up to 2 miles from the hamlet, but use was made of the journeys to and from the gardens to provide and fulfil

social obligations. In some cases the plots of several households were located so that heavy work was reduced by sharing, but in most cases household plots were established and tended in isolation from others. Taro accounted for 90% of the area planted, and this staple food was supplemented by plantings of a range of crops, including sweet potato, banana, pineapple, sugar, corn, and introduced vegetables such as tomato. The diet was supplemented by fruits from coconut and papaya trees which were planted throughout the area. Also by meat and some roots and fruit which were obtained by hunting and foraging in the forest and grasslands. The grasslands are regularly fired during the dry season to facilitate the search for food.

The Orokaiva were a highly individualistic society with the household head managing the affairs of his household more or less independently of others, especially in relation to agriculture. Nevertheless they found it necessary to co-operate with other households in a range of matters. Decisions on land rights, land use, and social and religious activities, were discussed at great length before the household head made up his own mind on a course of action.

Land was by far the most important resource of these people, yet they did not apply the concept of ownership to land. The traditional view of land was described by Reay(1969) as "rather like that of sea and air". The land belonged to everybody and was shared. Nevertheless the land was usually associated with a particular group, and usufructory rights for individuals were defined by the group and closely followed. Where land was plentiful it was usually controlled by a subclan, and usufructory rights were allocated on the basis of need to households within the subclan,

and occasionally to other subclans. Where land was in short supply sharing occured within a far more restricted group.

In the Inonda area control of the allocation of rights rested with the subclan, although the household heads of the subclan gathered periodically from their various hamlets, to discuss the distribution of usufructory rights. Similar meetings were held to discuss conflicts arising between individuals within the group, and occasionally meetings of members of two or more adjacent subclans were held to discuss boundary disputes, or the transfer of some land rights to meet a particular need.

Once allocated usufructory rights were generally transfered on the basis of patrilinial descent, and were strengthened by domicile. There were however many variations to this pattern. Under special circumstances rights accrued through the mother, or were granted to new-comers to the area. Occasionally they were held by non-residents, for example women of the subclan who are married and lived elsewhere, and household heads occasionally exchanged usufructory rights, with members of other subclans. It was not really practicable to keep an up to date list of names of those holding usufructory rights to a parcel of land.

On the other hand forest and grassland areas were generally not allocated to individual households and were available for foraging and hunting to all members of the subclan, and often to adjacent subclans. Where land was plentiful these group rights were seldom enforced.

Trees which produced food of value were usually planted by individuals holding usufructory rights to the land. However unlike the land, trees were owned and were often presented as gifts.

This led to the situation where individual households owned trees throughout the area, and these provided food and drink for members of the household in all the localities they visited during their local travels. These rights seem to have been respected by all.

3.3.2 Sevepe Village.

Rimoldi (1966) studied the people at Sevepe village in some detail. The village was located on the north slope of Mount Lamington, and in 1966 there were 166 inhabitants in the village in a rural area containing approximately 66 people per square kilometre and this was the highest population density in the district. The social structure of this area was markedly different from that at Inonda, the clans being widely dispersed, and with most clans represented in most villages (Rimoldi 1966). The people in this area were far more secretive than in other areas.

The situation may be understood better by reference to the history of the area. Early in this century the people lived in hamlets, and even then the population densities were high because the soil which was rich volcanic ash (Haantjens, 1964) provided rich rewards to agricultural endeavour. Fighting was prevalent in the area because of the high population density. Perhaps for this reason the resistance to the extension of expatriate administration was more sustained. During the second world war fierce fighting swept through the area twice forcing many inhabitants to take to the forests, and many starved there. In 1951 Mount Lamington erupted and local village people were forced down on the plains to the north. On their return after the eruption the population were more amenable to the expatriate

administration which encouraged them to forgo seperate hamlets and live in villages. Many felt that the Mount Lamington eruption was a punishment for resisting expatriate administration. At that time co-resident subclans negotiated among themselves for land near the villages. With expansion of the population fragments of subclans were forced to move to new villages further up slope. At the new location land rights were negotiated and later the process was repeated. Hence villages in this area contained lineage groups of various subclans from many of the clans of the area, and this had far reaching consequences for this society.

The need for land generated by population expansion greatly modified the pattern of subsistence agriculture. Although a fallow system was followed these fallows were reduced to 6 or even to 4 year periods (Rimoldi 1966). It is not clear to what extent the soils were affected. As a result of continual subdivision of land within a locality, and periodic extension of the perimeter of the lands shared, individual households usually harvested from a number of tiny widely dispersed plots. Rimoldi (1966) estimated the people of Sevepe required a total of 44 hectares to continue their cycle of fallow, and at the time they held rights to 55 hectares. Forest and even grassland had all but disappeared, and wild pig and wild fruit were no longer available. These food sources had been partially replaced by domestic production. In this new situation the influence and scope of old loyalties changed. The basic pattern of land rights remained, but the control of land by the subclan was gradually devolving on to the lineage groups co-resident in the village,

and with the weakening of subclan control, individual households had far greater control of their land than previously. Individual plots were now jealously guarded against incursions by adjacent plot holders, who often came from another village or even another clan. Individual households were looking more and more to their neighbours in the village for support in the increasing number of disputes over land.

Today the situation has not changed greatly in lightly populated areas. The description of the way of life at Inonda still holds true of large areas of the Northern District, although there are more young people today, and they are frequently disenchanted with the old ways. At Sevepe and at other more density populated areas residents are being forced to seek solutions to the pressing social problems created by the land shortage.

3.4 THE MODERN SECTOR ECONOMY.

The modern sector economy is small and poorly organized. The most reliable, and perhaps the most important sources of income and employment for the district, are the Government services. The Departments of Health and Education employ large numbers, and substantial numbers are employed in the Departments of the Prime Minister, Law, Agriculture and in the Police Force. Income is also provided by expenditures by these Departments on capital works, and on works organized by the Area Authority, and the 6 Local Councils with Government funds.

The local sawmill has a small production of approximately 1,200 m^3 per annum, much of which is sold to the Government, some being shipped to Lae. Although small the mill is labour intensive

and provides employment for over 100 people.

There was a time when expatriate agriculture, both individual and company-based, flourished in the District. Cattle were introduced to the Kokoda valley before the Second World War. Rubber has been firmly established since the 1950's. By 1953 there were 800 hectares at Kokoda and 1,400 hectares between Popondetta and Awala (Mann, 1953). Substantial coconut plantings were established on the Warisota Land system south-east of Popondetta after the war, and the Sangara blocks were settled and planted to cocoa in the early 1960's. During this period an extensive road system was developed to service these enterprizes. Today the rate of development has greatly declined. The cocoa plantations suffered a series of infestations of insect pest, the most serious of which, the Pantorrhyties beatle, could not be controlled. Most plantations were abandoned by the early 1970's, and are today overgrown. The coconut plantations were also largely abandoned at the approach of Independence. Today the rubber and cattle properties appear to be the only viable form of medium-scale agriculture in the District.

Small-holder cash cropping has received a great deal of encouragement from the Government since the mid 1960's. It also received a boost from the collapse of the cocoa enterprizes which caused many indigenous workers to start cash cropping. Today many indigenes receive a small irregular income from cash crops particularly coffee, rubber and cattle raising.

The transport and commercial sectors received a severe setback with the rundown in expatriate agriculture, and today the commercial sector is maintained largely as a result of the flow

of Government funds entering the district. The prosperity of the transport sector is supported by an excellent road system, and is closely linked to developments in cash cropping.

It seems the failure of expatriate enterprize, and the general withdrawal by expatriates at the time of Independence, has left behind a faltering economy with a limited capacity to provide employment.

3.5 UNEMPLOYMENT AND OTHER SOCIAL PROBLEMS.

A clear picture of the unemployment problems is given by Census statistics. Table 3.2 shows the change in the number of indigenes employed in the modern sector over this period. The "mainly money raising" group are those who usually work for money. The total money raising workforce includes this group, together with those who occasionally take paid work.

Table 3.2 CHANGE IN THE MODERN SECTOR WORKFORCE 1966-71.

	1966	1971
Mainly money raising	9,817	7,227
Total money raising	20,321	11.611

Sources : P.N.G. Bureau of Statistics (1966, 1971).

Table 3.2 shows the large decline in numbers of people mainly dependant on income in the monetary sector. Changes in employment in agricultural occupations are shown in Table 3.3.

Table 3.3 CHANGE IN INDIGENOUS EMPLOYMENT IN AGRICULTURAL OCCUPATIONS IN THE MODERN SECTOR 1966-71.

	Entrepreneurs		Employees	
	1966	1971	1966	1971
Vegetables	521	557	5,136	-
Copra	788	1,093	1,426	28
Cocoa	300	658	1,284	283
Cocoa & Copra	-	-	-	44
Coffee	2,679	4,078	5,034	73
Rubber	26	153	447	277
Oil palm	-	-	-	-
Beef and dairy cattle			-	32
Gardening			-	8
Grass cutting	59	113	175	335
Other			61	110
Totals	4,373	6,792	13,563	1,190

Source : P.N.G. Bureau of Statistics (1966, 1971).

Table 3.3 shows the drop in employment in the coconut, cocoa, and coffee plantations, which occured as a result of the reduction in expatriate agriculture. Altogether over 10,000 indigenes were displaced from the monetary sector in rural areas over the 5 year period, and it seems that relatively few of those displaced began cash cropping. Today unemployment would be worse because health measures introduced a generation ago have resulted in far more young people reaching working age.

Table 3.4 shows the change in the age distribution in the Northern District between 1966 and 1971.

Table 3.4 AGE DISTRIBUTION IN THE NORTHERN DISTRICT IN 1966 AND 1971.

Age group	Total Population (number)		Total Population (percent)		Increment in age group over 5 years.
	1966	1971	1966	1971	
0-9	19,952	23,919	34.4	36.0	3,967
10-19	12,096	13,903	20.9	20.9	1,807
20-29	8,561	9,420	14.8	14.2	859
30-39	7,144	7,435	12.4	11.2	291
40^{+}	10,214	11,241	17.5	17.7	1,027
Total	57,967	65,918			

Source : P.N.G. Bureau of Statistics (1966, 1971).

It seems from Table 3.4 that the numbers in the working age groups from 15-40 increased by approximately 1,500, and there will be progressively greater increases as time passes.

These increases are even more significant when considered with educational levels of those entering the workforce. Table 3.5 shows the change in numbers who had reached various educational levels in 1966 and in 1977.

Table 3.5 NUMBERS OF INDIGENES AT VARIOUS LEVELS OF EDUCATION IN THE NORTHERN DISTRICT IN 1966 AND 1971.

Level of Education	1966	1971
Leaving	1	33
School Certificate	3	151
Intermediate & Junior	23	316
Form 2	549	601
Totals	576	1,001
Total with some primary	26,291	28,175

Source : P.N.G. Bureau of Statistics (1966, 1971).

Table 3.5 shows that the numbers of indigenes with some secondary education doubled within a period of 5 years, and the increase was far greater at senior levels. At the time those with substantial secondary education were easily able to find employment in the major centres. Moreover the increase in numbers with secondary education has continued, and today a large percentage of those seeking work cannot find employment. One result of this rapid increase in unemployment among the more educated indigenes has been the shift of population to Popondetta. By 1971 Popondetta had doubled in size to 4,136 and then contained 8% of the people of the District. The population of Popondetta has continued to grow as have the sort of concommitant social problems described in Section 2.4.

There is obviously an urgent need to create substantial numbers of employment opportunities in both the urban and rural areas of the Northern District.

CHAPTER 4

THE FOREST RESOURCE

4.1 LOCATION.

The forest resources of the Northern District form part of the South East Coastal Forest System, which extends from Mullins Harbour north-west to the Huon Peninsula. Most of the commercial forests are located between 0 and 300m a.s.l. and are predominantly lowland rainforest. These areas are stocked with a wide range of species. The species mix varies between localities but frequently one or a few predominate to give a patchwork of forest types. Further large areas of the lowlands are swamp and are vegetated with sago palm or mangrove. The hill country which borders the lowlands frequently carries better stands of timber. Dipterocarp spp. are the most common and these sometimes form almost pure stands.

The best forests in the Northern District flank the Kumusi River where it turns towards the coast (see Map No.1(1)), and these may be divided into several distinct areas. The Saiho forests lie to the north of the main road which skirts the north slopes of Mount Lamington, and they extend east from the Kumusi River towards Popondetta. The Kumusi forests lie further north across an extensive belt of grassland, and cover much of the land inside the bend of the Kumusi River. Both forests occupy gently sloping or flat topography. The only significant topographic features are

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(1) See Appendix E

occasional broad deep gullies which carry water courses of moderate size. Most of the forest occupies rich well drained brown volcanic ash soil (Haantjens, 1964). The north-west section of the Kumusi forest, adjacent to the bend in the river is the exception. This area, approximately one third of the total Kumusi forest area, occupies alluvial soils which are rich but poorly drained. My experience with forests elsewhere in the district suggests such a forest growing on alluvial soils would be relatively poorly stocked.

The forests of Ioma Block 5 occupy the area across the river from the Kumusi forest on alluvial soil, and stretch from the river bank back into the foothills of the main range. The alluvial plain is vegetated with lowland rainforest similar to that in the Saiho area, but there are some small isolated stands of almost pure Anisoptera. The hill forests beyond are composed of quite different forest types.

4.2 INVENTORY.

Inventory data for these forests was published in summary form in the Kumusi Forestry Development Proposal (T.P.N.G. Department of Forests, 1971), to enable interested parties to tender to develop the area.

The forests were inventoried in the late 1960's using a method developed over the previous decade by the Department of Forests. This method is considered to provide adequate resource information with reasonable efficiency. Inventory crews survey radiating traverse lines from helicopter pads cut at selected

locations in the forest. The pad locations are selected from air photos in the office. The pads are located so that radiating traverse lines provide a reasonable sample of the forest. Measurement plots are 20.1m (1 chain) radius and spaced at 100m (5 chain) intervals. Species and girth above buttress (g.a.b.) are recorded, and volumes are subsequently estimated by means of Forest Department volume tables.

Table 4.1 POTENTIAL SAWLOG VOLUME.

Locality	Productive Area (hectares)	Sample Intensity (percent)	Total volume 50^{+} cm g.a.b. (million m3)
Saiho	5,543	0.27	0.330
Kumusi			
Ash soil	16,230	0.44	1.315
Alluvial soil	8,115		0.658
		Total	2.203
Ioma			
Lowland forest			
Anisoptera absent	12,460	0.215	0.760
Anisoptera present	109	0.701	0.009
Hill forest	18,539	0.283	1.639
		Total	2.408

Source : T.P.N.G. Department of Forests (1971).

The breakdown of the Kumusi forest resource into two parts is based on personal judgement. Table 4.1 shows that the potential sawlog resource is divided into approximately equal parts by the river. On the Popondetta side the bulk of the sawlog volume is located on the Kumusi ash soils. On the Ioma side of the river the bulk of the sawlog volume is located in the hill forest.

The general estimates in Table 4.1 seem sufficiently reliable for planning resource development. Some reduction of these resources will have occured since the survey because of the expansion of shifting agriculture, but the forest destroyed would not be significant because population is low in these areas (see Chapter 3).

Table 4.2 shows the species groups, the major species, their percentage composition, and total volume, for each forest area. It also shows the estimated suitability of species by product category. The suitability of the various species for sawn-wood and veneer is based on evaluations made by the Forest Department (T.P.N.G. Department of Forests, 1966). Suitability of species for chipwood is determined by basic density, those species with a basic density of 653 kg per m^3 (12% M.C.) or less being considered suitable.

Table 4.2 SPECIES PERCENTAGE COMPOSITION, TOTAL VOLUME, AND POTENTIAL USE, BY FOREST AREA, SPECIES GROUP AND USE CATEGORY.

(a) Saiho Forest Area.

Group and species	Total Volume		Product		
	Percent	000'm^3	Veneer	Sawn Wood	Chip
Walnut & Ebony					
Dracontomelum	0.23	1	*	*	*
Cabinet Woods					
Elmerillia	5.54	18	*	*	*
Dysoxylom	2.16	7	*	*	
Palaquium	3.90	13		*	*
7 others	6.74	22		*	*
Construction Hardwoods					
Pometia pinnata	28.28	93		*	
Celtis	5.84	19	*	*	
Terminalia	2.94	10		*	*
Canarium	2.22	7		*	*
Parinarium	2.46	8			
9 others	4.88	16		*	
Medium Density Hardwoods					
Cryptocarya	6.47	21		*	*
Chisocheton	4.27	14		*	
Alstonia	5.80	19		*	*
Newbergia	2.76	9			*
Planchonella	1.80	6	*	*	*
Cinnamomum	3.25	11	*	*	*
Litsea	1.29	4		*	*
8 others	7.22	24		*	*
Low Density Hardwoods					
15 species	1.93	6			*

Table 4.2 (cont.)

(b) Kumusi Forest Area.

Group and species	Total volume		Product		
	Percent	000'm^3	Veneer	Sawn Wood	Chip
Walnut & Ebony					
Dracontomelum	1.80	35	*	*	*
Diospyros	0.72	14	*		
Conifer					
Podocarpus	0.20	4	*	*	*
Cabinet woods					
Palaquium	5.58	110	*	*	
Dysoxylon	1.42	28	*	*	
Campnosperma	1.91	38		*	*
Elmerillia	0.88	17	*	*	*
Gmelina	0.96	19		*	*
Amoora	0.53	10		*	*
Pterocarpus	0.86	17	*	*	*
5 others	2.51	49		*	*
Construction Hardwoods					
Pometia pinnata	13.33	263		*	
Burchella	7.21	143			
Celtis	6.53	129	*	*	
Anisoptera	4.29	85	*	*	*
Neonauclea	2.64	52		*	
Dillenia	4.21	83		*	*
Intsia	1.96	39		*	
Terminalia	1.38	27		*	*
17 others	7.51	148		*	
Medium Density Hardwoods					
Cryptocarya	4.93	97		*	*
Planchonella	3.57	70	*	*	*
Litsea	1.16	23		*	*
19 others	12.77	252		*	*
Low Density Hardwoods					
24 species	11.14	220			*

Table 4.2 (cont.)

(c) Ioma Lowland Forest Area.

Group and species	Total volume		Product		
	Percent	000'm^3	Veneer	Sawn	Chip
Walnut & Ebony					
Dracontomelum	2.00	5	*	*	*
Diospyros	0.12	1	*	*	
Conifer					
Podocarpus	0.38	3	*	*	*
Cabinet Woods					
Aglaia	0.95	7	*	*	
Amoora	0.46	3		*	*
Calophyllum	2.69	20		*	*
Campnosperma	2.17	16		*	*
Dysoxylom	2.11	16		*	
Gmelina	1.12	9		*	*
Palaquium	2.02	15		*	*
3 others	0.80	6		*	*
Construction Hardwoods					
Anisoptera	3.33	25	*	*	*
Burchella	2.04	-			
Dillenia	6.67	51		*	*
Eugenia	3.63	28		*	
Garcinia	2.86	22		*	
Hopea	13.36	101		*	
Neonauclea	2.17	16		*	
Parinarium	3.15	27			
Pometia tomentosa	2.51	19	*	*	
Pometia pinnata	10.96	83	*	*	
Terminalia spp.	2.85	22		*	*
12 others	6.96	53		*	
Medium Density Hardwoods					
Crytocarrya	3.31	25		*	*
Elaeocarpus	1.86	14		*	*
Endospermum	1.13	9	*	*	*
Litsea	2.41	18		*	*
Planchonella	1.61	12	*	*	*
13 others	6.23	47		*	*
Low Density Hardwoods					
11 species	3.22	24			*
Unknown	4.53	34			*

Table 4.2 (cont.)

(d) Ioma Hill Forest Area.

Group and species	Total volume		Product		
	Percent	000'm^3	Veneer	Sawn Wood	Chip
Walnut & Ebony					
Dracontomelum	0.62	10	*	*	*
Diospyros	0.08	1	*	*	
Conifer					
Podocarpus	1.13	2	*	*	*
Cabinet Woods					
Aglaia	1.00	16	*	*	
Amoora	0.96	16		*	*
Calophyllum	4.81	79		*	*
Palaquium	1.46	24		*	*
7 others	3.98	65		*	*
Construction Hardwoods					
Anisoptera	35.43	581	*	*	*
Dillenia	1.66	27			
Eugenia	4.74	78		*	
Garcinia	2.52	41		*	
Hopea	11.80	193		*	
Pometia tomentosa	2.10	34	*	*	
Pometia pinnata	2.02	33	*	*	
20 others	11.80	193		*	
Medium Density Hardwoods					
Cryptocarya	1.89	31		*	*
Litsea	1.39	23		*	*
Planchonella	1.32	22	*	*	*
20 others	4.34	71		*	*
Low Density Hardwoods					
12 species	1.84	30			*
Unknown	4.11	67			*

Table 4.2 shows that species composition of all forests is very mixed, but in all cases a large proportion of the volume is provided by a few species. The construction hardwood Pometia pinnata is the major species throughout the lowland rainforests, of the area. Table 4.2 (d) shows the Ioma hillforest is dominated by Anisoptera and to a lesser extent by Hopea spp., and Hopea spp. are also common in nearby forest. The construction timbers are heavy all purpose timbers and it seems most can provide good sawn timber, although most are too heavy to be peeled or sliced for veneer. Medium density hardwoods are utility timbers used mainly for indoor work. Few appear suitable for veneer. The cabinet woods have similar densities to the medium density hardwoods, but they also have colour or figure which makes them usefull for exposed surfaces where an effect is needed. Most seem to be suitable for sawn timber, and some are suitable for veneer. Walnut and ebony are valued special purpose timbers which are best used for veneer. Low density hardwoods are generally not suitable for sawntimber or veneer.

Higgins and Phillips (1973) classify the suitability of eucalypt material for chip according to basic density because heavy timbers usually contain a high percentage of extractive, provide low yields of pulp, and often prove difficult to process. This question is discussed futher in Chapter 5. Anisoptera polyandra, an important construction timber, can be pulped satisfactorily (Phillips et al., 1975). This species has a basic density of 656 kg per m^3 (12% M.C.) (T.P.N.G. Dept of Forests, 1966), and has been taken to be the heaviest timber suitable for chipping from these forests.

4.3 SAWLOGS AND VENEER LOGS.

The gross estimate of potential sawlog volume shown in Table 4.1 was adjusted to allow for forest reservation and defect. It is Forest Department practice in Papua New Guinea to leave reserves of forest in areas harvested to provide the local people with a continuing source of a variety of timber, fruit, and other materials,which they require to maintain their customary life-style. The reserves also help conserve the rich flora, and somewhat less rich fauna, of these forests. Allowance has been made to reserve 10% of the area for these purposes.

Defect is sometimes recognized by field inventory teams and excluded from the sample estimate. For example the presence of heart rot can often be recognized by the presence of external symptoms such as swellings on the bole. However in many cases the defect in standing trees may be high. An allowance of 20% by volume for heavy construction timber, and 40% by volume for other sawlog species was made for defect. These allowances were based on discussion with a forester experienced in the type. (McCarthy, pers. comm.). Burchella, a species which is frequently very defective, was also completely excluded from the resource volume estimates on the basis of Forest Department practice (T.P.N.G. Dept. of Forests, 1971). The adjusted estimates of sawlog volume, and volume per hectare by forest area are shown in Table 4.3. The volume of timber suitable for rotary and sliced veneer is included in these estimates.

Table 4.3 SAWLOG VOLUME AVAILABLE BY FOREST AREA.

Forest Area	Area	Volume 50^{+}cm g.a.b.	
	(hectares)	(thousand m^3)	(m^3 per ha)
Saiho	4,989	193	38.69
Kumusi			
Ash soil	14,607	844	57.78
Alluvial soil	7,303	169	23.14
Ioma block 5			
Anisoptera absent	11,214	437	38.97
Anisoptera present	100	7	70.00
Hillforest	16,685	1,032	61.85

Source : T.P.N.G. Department of Forests (1971).

It seems from Table 4.3 that the relative importance of the various areas are little changed by the adjustments for area and defect. The forests on the Kumusi ash soils and the Ioma hill forests are far better stocked than most of the other areas. The best stands appear to be those dominated by Anisoptera.

Table 4.4 shows the estimated veneer log volume and volume per hectare by forest area.

Table 4.4 VENEER LOG VOLUME AVAILABLE BY FOREST AREA.

Forest Area	Area	Volume 50^{+}cm g.a.b.	
	(hectares)	(thousand m^3)	(m^3 per ha)
Saiho	4,989	39	7.82
Kumusi			
Ash soil	14,607	266	18.21
Alluvial soil	7,303	53	7.36
Ioma block 5			
Anisoptera absent	11,214	118	10.52
Anisoptera present	100	7	70.00
Hillforest	16,685	354	21.22

Source : T.P.N.G. Department of Forests, (1971).

It seems from Table 4.4 that there is a limited stocking of species suitable for veneer in all forest areas. These species are especially poorly represented in the Saiho forests and the Kumusi alluvial soil forest. The Anisoptera stands which occur on the Ioma side of the river carry the greatest volume of veneer log species. In general the proportion of log suitable for veneer in the area is low in comparison to some other areas of Papua New Guinea.

4.4 CHIP WOOD.

The Forest Department estimated there were 2.009 million m^3 of chipwood in the Kumusi Saiho area in size classes from 15 to 50 cm g.a.b. (T.P.N.G. Department of Forests, 1971). After adjustment of this figure to allow for reserves, the estimated volume was 2.005 million m^3. A further 0.352 million m^3 of chipwood was estimated to be available on the basis that 50% of trees rejected for sawlog were suitable for chipping. Hence the volume of available chipwood for the Kumusi-Saiho area was estimated to be 2.157 million m^3 or about 80 m^3 per hectare.

The Ioma block 5 lowland forest appears to be similar to much of the Kumusi-Saiho area. On this basis the Ioma lowland forest was estimated to contain 0.905 million m^3 of chipwood. Further material would be available from the hill forest, but no attempt has been made to estimate this volume because it seems unlikely to be economically exploitable.

4.5 ACCESSIBILITY AND INFRASTRUCTURE.

The nearest deep water port to the Kumusi-Saiho forest area is at Oro Bay to the south-east (see Map No.1(2)). Potential access to these forests is good. The terrain within these forests and between the forests and Oro Bay is largely flat and reasonably well drained, although some areas within the forest close to the bend in the river are poorly drained. However access to the Ioma Block 5 forest is blocked by the Kumusi River, which carries substantial flows even during the dry period of the year.

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(2) See Appendix E

Substantial infrastructure is already available. A wharf capable of berthing overseas ships of the order of 20,000 tonnes was constructed in the early 1970's. This is linked to Popondetta and Kokoda by an all weather gravel road. The bridges on this road are substantial and are capable of carrying semi-trailors and conventional trucks with all-up weights of 33 and 24 tonnes respectively (T.P.N.G. Department of Forest, 1971). Although this road runs to the south of the forest area (see Map No. 1), there are many 4 wheel drive trails radiating towards and through the Kumusi and Saiho forest areas from the road, and from Popondetta further east.

Popondetta is a substantial town. In 1971 the town had a population of 4,500 people but would be considerably larger today. The town has power, water, and telephone services, and some land is available for industrial development.

Extension of the road network to the Kumusi and Saiho forest areas could be achieved at relatively low cost. The terrain is easy and adequate roading material is available from the Kumusi river-bed. Concrete bridges would be required to span the occasional deep gully which intersects the ash soils in the Saiho area, but these would be few in number. However construction of an access route to the Ioma block 5 forest would be very expensive. A high level reinforced concrete bridge with spans totalling 150 m approximately would be required at a location in the vicinity of Siai in the north-west of the Kumusi forest. The cost of this bridge may determine whether the Ioma Block 5 forest can be developed economically.

CHAPTER 5

A FOREST BASED DEVELOPMENT STRATEGY.

5.1 SPECIFICATION OF A STRATEGY.

One feasible strategy is based on the establishment of a sawmill, chipmill, and ancilliary operations. The sawmill would have a capacity of 73,000 m^3 log per annum, and would be sited at Popondetta. The chipmill would have a capacity of 400,000 m^3 log per annum and would be sited at Oro Bay. Both mills would be constructed in stages to allow time to organize operations, train staff, and arrange financing. Construction of a chipmill would be delayed 8 years to allow the company time to accumulate capital, and to cushion the impact of the development on the social environment. The resulting schedule of log inputs to the mills is shown in Appendix A . Logging operations of both mills would be integrated when the chipmill begins operation and sawmill residues would be sent to the chipmill for further processing. The estimated period of logging in each forest area is shown in Table 5.1.

Table 5.1 PERIOD OF HARVESTING OPERATIONS BY FOREST AREA (years)

	Sawlog		Chiplog	
	Start	Finish	Start	Finish
Saiho	2.0	6.1	14	17
Kumusi				
Ash soil	6.1	17.6	11	17
Alluvial soil	17.6	20.0	18	20
Ioma Block 5				
Lowland rainforest	20.0	26.3	21	26
Hillforest	26.3	40.0	-	-
Plantation	-	-	13	-

Table 5.1 shows that the Saiho, Kumusi, and Ioma Block 5 forest areas would be logged in sequence. Logging for chipwood would begin at the time harvesting operations move from the Saiho area to the Kumusi area. In the Kumusi area and the lowland area of Ioma Block 5, sawlog and chiplog harvesting would be supplemented by log from the Saiho area and the plantations. Beyond year 26 sawlogs would be harvested in the hill forest, while chiplog would be harvested from plantations.

The milling operation proposed seems feasible. Sawmilling, a relatively simple operation, would be a suitable industry for a developing situation. Further more the scale of the mill would be sufficient to provide a continuous supply of each category of sawn timber which would be very important in marketing. Markets should be available. The sawn timber market in Japan has a growing deficit. (Ferguson and Parkes, 1976 a). Australia is also a reasonable market

A sawmill at Popondetta would be well placed to supply these markets. The port to port distance is relatively short. Moreover much of the necessary infrastructure required for the development is already available. This should offset the high transport costs resulting from the relatively long distance from the Forest areas to Oro Bay.

The chipmill also seems likely to be feasible. The Japanese market for chipwood seems likely to continue to increase once the effect of the world recession in trade and economic growth has passed (Ferguson and Parkes, 1976 b). Recent technological advances have enabled a much wider use of hardwood in pulping and Japanese pulp mills have been buying increasing quantities of this cheaper raw material. Although most purchases to date have been of Eucalyptus spp. from Australia (Higgins et al., 1973), Japan New Guinea Timbers Lmt. have initiated the export of mixed tropical hardwood from their Madang mill. A chipmill at Oro Bay should be in a similar competitive position to the Madang mill. It would have the same advantages of scale which seems to be vital to profitability. The long forest to port distance would be a considerable disadvantage,but this would be offset to some extent by the availability of infrastructure.

Government approval for such a project should be forthcoming. Integrated logging of the forest,and the considerable value added by milling,provide for efficient used of the resource from the nations point of view. Furthermore much of the income and employment would be created in rural areas of a relatively undeveloped District which is in line with Government policy. Moreover it should be possible to limit the undesirable social effects of

the development.

This strategy is only one of several possible alternatives, all of which merit analysis before a decision is taken. Such analyses are beyond the resources available for this study. Indeed, complete analysis of the present strategy is beyond the scope of this study. The analysis which follows will cover only one part of the strategy, the plantation project. The plantation project has the advantage of being largely self-contained.

5.2 OUTLINE OF THE PLANTATION PROJECT.

An objective of the plantation project is to avoid the necessity to harvest rainforest for chiplog independantly of sawlog harvesting operations, and to provide the chipmill with a sufficient life. Table 5.2 shows the sources of inputs for the chipmill including the supply from the plantations.

Table 5.2 SCHEDULE OF LOG INPUTS TO CHIPMILL BY SOURCE (thousand m^3)

Year	Integrated Rainforest Logging	Sawmill Residues	Saiho and Secondary Forests	Plantation
1				
2				
3				
4				
5				
6				
7				
8				
9				
10	-	-		
11	50	27		
12	101	27		-
13	101	27	-	100
14	101	27	100	100
15	101	27	150	112
16	101	27	150	112
17	161	27	100	112
18	252	27		121
19	252	27		121
20	252	27		121
21	188	27		185
22	188	27		185
23	188	27		185
24	188	27		185
25	188	27		185
26	65	38		297
27	-	44		363
28		44		363
29		44		363
30		44		363
31		44		363
32		44		363
33		44		363
34		44		363
35		44		363
36		44		363
37		44		363
38		44		363
39		44		363
40		40		363
41		-		363
42*				363

* Beyond year 42 supply is from plantations.

Table 5.2 shows that approximately 45% of chiplog would be provided by the rainforest logging operation during the period of logging in the Kumusi, Saiho, and Ioma Block 5 lowland rainforest areas. During this period there would be a substantial contribution from sawmill residues. Moreover the plantation project would supply approximately 45% of chiplogs required. Beyond year 26 chipwood would be supplied by the Plantation Project and supplemented by sawmill residues from trees logged in the hill forest. If the Ioma Block 5 were not logged, or if it proved uneconomical to harvest chiplog in that area, then increased plantation supplies would be required from year 20. A decision to increase planting rates could be made as late as year 9 for plantations with a rotation length of 10 years, but this possibility will not be explored in the analysis which follows.

5.3 PLANTATION SPECIES AND LOCATION.

5.3.1 Potential Plantation Species.

Tree species with forestry plantation potential in Papua New Guinea were reviewed by Dun and Fenton (1974). Data from a wide range of species and provenance trials, and a variety of production plantings were considered. Dun et al.(1974) concluded there were several species with good prospects as plantation species on lowland sites. The best prospects were :

Eucalyptus deglupta Bl.

Terminalia brassii

Pinus caribaea Morelet

Eucalyptus tereticornis Sm.

Dun et al.(1974) considered all 4 species suitable for chip wood. The 3 hardwoods would be suitable substitutes for rainforest chipwood.

E. deglupta has the best growth rates of the hardwoods. This indigenous species has a discontinous natural range from Mindinao in the Phillipines to Papua New Guinea. It grows at elevations between 0 m and 760 m, where temperatures ranges from 24°c to 33°c, and annual rainfalls are between 2,500mm and 3,500mm. The species prospers under a wide range of seasonal rainfall distributions. In some cases monthly rainfalls are only 150mm per month, but the species seldom tolerates prolonged dry seasons (Davidson, 1973a). The best stands in Papua New Guinea are those in East New Britain on river-rain sites at elevations of less than 150m.

There have been trials of E. deglupta at a number of sites. On deep moderately fertile sands and on well drained volcanic ash soils, growth rate are very high. Mean annual increment of some 16 years old plots at Kerevat was 40 m^3 per ha. per annum (Davidson and Fairlamb, 1973). Moreover the Kerevat average growth rate to age 15 was 31.5 m^3 per ha. Younger trials on poorly drained sites of low fertility have not been promising, even with elaborate site preparation. Data presented by Lamb (1975) suggests that under these conditions the rate of growth would be fast at first but would then decline.

E. deglupta has several valuable attributes for a plantation species apart from growth rate. The species seeds prolifically, and adequate quantities of seed of all major provenances are readily available (Dun et al.1974). There seem to be

no serious fungal or insect problems for the species when grown in plantation (Dun et al., 1974). Heart rot is no longer thought to be a problem (Lamb et al., 1974). Furthermore the wood is suitable for pulping.

It seems likely this species would provide outstanding growth in lowland areas provided the soils are deep, reasonably fertile, and most importantly, well drained. In addition rainfall exceeds 2,500 mm per annum, and mean monthly rainfalls do not fall below 150 mm for periods exceeding 3 months. In the Northern District this species seems likely to grow extremely well on the ash soils on the slopes and plains north of Mount Lamington, but not elsewhere on the coastal plain.

T. brassii is found in natural stands at several places, on Bougainville, New Britain, and in the Solomons. This light hardwood has similar early growth rates to E. deglupta (Dun et al., 1974). The species likes rich soil and wet feet. It seems suited to the Sagare Land System (see Map No. 2(1)). Unfortunately there is no known way of storing the seed of this species, and there have been problems with case moth and stem borer (Dun et al., 1974). Thus the species does not appear a good prospect as a plantation species for the Northern District.

E. tereticornis is an indigenous species found throughout the savannah regions of Southern Papua. It is commonly found in areas which experience a marked dry season and recurrent fires. Dun et al. (1974) suggested that the species may produce 35 m^3 per ha per annum on swampy grassland in the lowlands, but this claim was not substantiated. Lamb (1975) reported the species succeeded reasonably well on low fertility poorly drained clay loam soils

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(1) See Appendix E

over fine textured subsoils in a lowland grassland site in the Sepik. Under these conditions height growths were up to 5 metres in 3 years. This suggests the species may perform reasonably well on the better drained block volcanic sands and fine to medium alluvial soils, of the Popondetta and Penderetta land systems respectively.

5.3.2 Growth Conditions and Present Utilization of Agricultural Land.

Easy access in the Northern District is limited to areas within reach of the road system. Fortunately most of the very good soils fall within these areas. The best soils are those on the slopes and plains to the north of Mount Lamington. Excellent volcanic ash soils cover the Awala, Bohu, and Eundi Land Systems. The Sagari Land System is also covered with excellent soils but these are of alluvial origin (see Map No.2(2); Haantjens, 1964). Further west there are excellent brown soils on the rugged ranges bordering the Ioma Block 5. There are also some reasonably good alluvial soils on the Popondetta, Penderetta, and Warisota Land Systems of the depositional plain, and further patches of good soil in the Ilimo and Kokoda areas. Most other soils in the general area are rather poor.

Rainfall is high throughout the district and is generally well distributed throughout the year. Figure 5.1 shows the rainfall distributions at Ioma and Buna.

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(2) See Appendix E

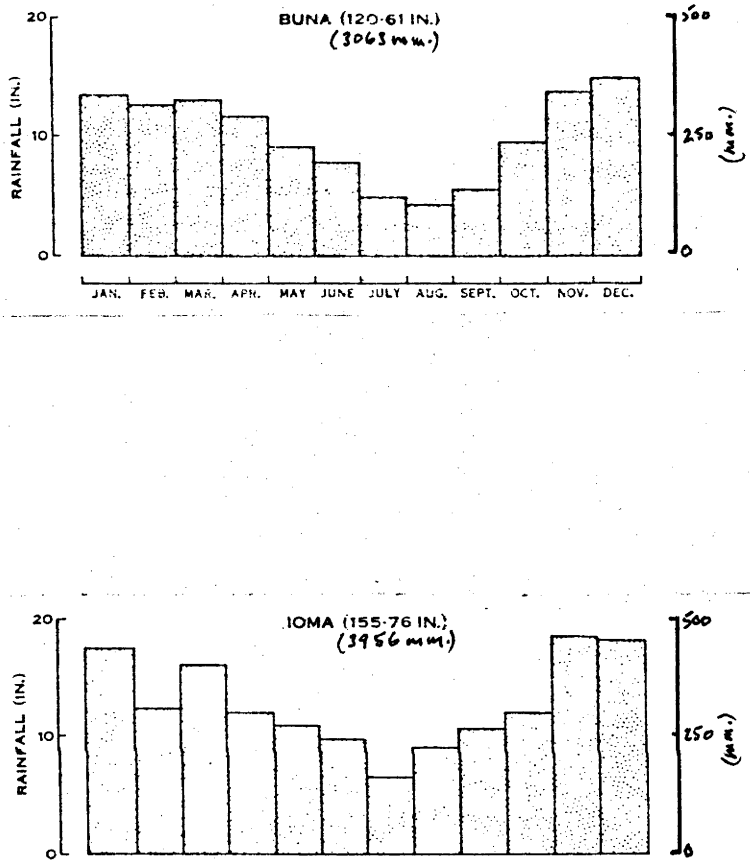

Figure 5.1 Distribution of monthly rainfall at Ioma and Buna.
Source : Haantjens (1964).

Figure 5.1 shows that the rainfall is high at both locations. It is higher inland at Ioma than at Buna on the coast. The rainfall pattern is similar at both locations with the lowest mean monthly rainfalls occuring in June to September.

There is a minimum mean monthly rainfall of 150 mm at Ioma and 100 mm at Buna. Temperatures in the area seldom fluctuate beyond the limits of 21°c and 35°c (Haantjens, 1964). These high and uniform temperatures together with the excellent rainfall provide near optimum conditions for plant growth for most of the year throughout the area.

Slope constitutes a major limitation on the use of the excellent ash soils to the north of Mount Lamington and the brown soils to the north-west, a good deal of which is too steep to utilize. Even the areas of moderate slope at the foot of Mount Lamington south of the road are deeply dissected and would be difficult to cultivate on a large scale. Wet season drainage is the major limitation on use of the rich alluvial soils of the Sagari Land System. It may however be economically feasible to drain the area (Haantjens, 1964). The value of the soils of the Popondetta and Penderetta Land Systems on the depositional plain is limited by a combination of light soil texture and relatively low dry season rainfall. These areas pose significant problems for shallow rooting plants. On the other hand the value of the moderately good soils of the Warisota Land System is limited by wet season flooding. Other soils of the depositional plain are of little value for agriculture or grazing because of low fertility and periodic flooding.

Presently most medium scale rural agriculture is restricted to the Kokoda valley. Rubber and cattle are the principal activities. Medium scale agriculture elsewhere in the District has largely been abandoned. Small scale agriculture and grazing is grouped around centres where services are available. The

coconut plantations which occupy the Warisota Land System are still worked intermittantly by indigenes. There are many small scattered grazing properties of 10 or 15 hectares in the grasslands near Popondetta and near Ilimo over the Kumusi River, and many plots of coffee and cocoa scattered through the area adjacent to the road between Popondetta and Ilimo. Most of these receive government advice and encouragement. The many small plots of rubber trees are clustered around the expatriate plantations at Kokoda. Plots used for subsistance agriculture are scattered throughout the district.

5.3.3 Government Policy and Future Land Development.

Government policy is likely to determine the pattern of agricultural development in Papua New Guinea. The Government places a high priority on small scale rural production of any agricultural commodities for which a market can be found. Large scale activities are encouraged if they are likely to earn substantial foreign exchange. Government support is expected for producers of the major food imports, meat, fish, vegetables and rice, and for producers of those agricultural commodities which may be sold profitably on the world market. The latter include coffee, cocoa, rubber, copra and oil palm. The Government intends to protect such producers by import regulation (P.N.G. Central Planning Office, 1973). Such agriculture is likely to flourish in suitable areas in the future. Thus the economic value of good land in the Northern District is expected to rise gradually. It is important to plan the location of long rotation crops such as forestry plantation to ensure they are sited where they remain

economically competitive over a time span of at least one rotation and preferably more. An important early step in site selection is a consideration of the likely course of agricultural development in the District.

Agreement was reached earlier this year to establish an oil palm processing factory and plantations in the Popondetta area (Far East Economic Review, July 30 1976). The plantations are likely to occupy most of the Sangara blocks area to the west of Popondetta (see Map No.1(3)). This is the only large scale enterprize likely to be developed in the near future. Medium scale development of rubber and cattle is likely in the Kokoda valley where the rainfalls remain high throughout the year, but not elsewhere.

Small scale cash cropping of a number of commodities is expected to spread through the area in a reasonably predictable way. Vegetables should be grown on those restricted areas of good soils which have good access to both water and the Popondetta market. Rice cropping which requires a rich fine textured soil on flat terrain and copious irrigation water, seems likely to be developed on the Sagari Land System (Haantjens, 1964). Rice crops could be planted on areas cleared of rainforest in the Kumusi area. Coffee crops are susceptible to sustained droughting or exposure, but otherwise tolerate most soil conditions (Morawetz, 1966; Federation of Malaya, 1958), and may spread over most of the higher rainfall area near the road, particularly in areas to the west of Popondetta. Cocoa is a more susceptible species which requires a rich well drained soil (Henderson, 1954; Federation of Malaya, 1955), and may be restricted to the sloping well drained volcanic soils on the north slopes of Mount Lamington, south of the road. In the

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(3) See Appendix E

Northern District cattle grazing is a very productive form of land use because of the excellent year round fodder production. Introduced grass species may increase productivity even further (Anderson, 1961; Gallasch , 1971). Thus cattle grazing is expected to spread fairly rapidly through all grassland areas. There should be little competition because of the difficulty of establishing cultivated crops on grassland. Small scale oil palm and rubber planting is likely to be restricted to the vicinity of the larger plantations in the Sangara blocks and Kokoda areas respectively. The rate of expansion of small scale agriculture will largely depend on the efforts of government extension services. Areas near the road are expected to benefit most. However because capital available is limited, the general rate of agricultural development is expected to be rather slow in all areas.

5.3.4 Plantation Species and Location.

The species with most potential in the Northern District are E. deglupta and E. tereticornis. However they require different sites. E. deglupta is likely to grow only on the volcanic soils of the Higaturu, Awala, Bohu and Eundi Land Systems, whilst E. teriticornis may grow reasonably well on the far less valuable black volcanic sands and fine to medium alluvials soils nearer the coast.

The choice of species and site is largely influenced by the availability of land. South of the main road to the west of Popondetta there is already a shortage of land, and social conditions preclude any plantation development (see Chapter 3). Moreover the Sangara blocks area a short distance to the west of

Popondetta (see Map No.1(4)) seems to have been committed to large scale oil palm plantation, and this may lead to nearby areas being planted to oil palm by indigenous people. The area some distance to the north of the main road between Agenohumbo and the Kumusi River seems to be the only suitable site for forestry plantations of E. deglupta. Land values are very low in this area at present because of low population and it may be some time before the demand for land in this area increases.

Land suitable for planting E.teriticornis is also restricted to one locality. Much of the Warisota Land System is already occupied by neglected but still useful coconut plantation. Moreover the grasslands surrounding Popondetta are being rapidly developed for cattle raising. The only area which is suitable and available for planting E. tereticornis seems to be that part of the Popondetta Land System adjacent to the Warisota Land Sytem. For both species planting should be located on relatively uninhabitated grassland and forest areas for reasons noted in Chapter 3.

Selection between the pair of species and site combinations also depends on their relative profitability. Table 5.3 shows for two possible plantation projects some characteristics which relate to profitability.

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(4) See Appendix E

Table 5.3 CHARACTERISTICS OF TWO POTENTIAL FORESTRY PLANTATION PROJECTS.

	Project	
	No. 1	No. 2
Land system	Bohu land system	Popondetta land system
Soil type	brown volcanic clay	mainly black sandy volcanic
Soil moisture	always high	surface soil subject to droughting
Drainage	good	poor at depth
Species	E. deglupta	E. tereticornis
Rotation length (years)	10	15
Wood production (m^3 per ha per ann.)	25	17
Cost of establishment		
Grassland	moderate	substantial
Rainforest	moderate to high	-
Cost of roading	low	low to moderate
Distance from port (km)	80	40

The rotation length and production estimate for E. deglupta shown in Table 5.3 are based on reports of present practices and species trial information of the Papua New Guinea Department of Forests (Dunn et al., 1974). The growth rate of 25 m^3 per ha per ann. is that used by Dunn et al. (1974) when discussing the potential production from E. deglupta plantations. The rotation length for E. teriticornis of 15 years is that

suggested by Dunn et al.(1974). The production estimate is that suggested by a comparison of the two rotation lengths. The production estimate for E. tereticornis is smaller than that Dunn et al.(1974) feel may be achieved. My personal feeling is that it is possibly still a little optomistic for the Northern District site.

The relative profitability of the two species and site combinations would depend on establishment costs, species productivity, and harvesting and transport costs. The cost of establishment would be similar at both potential sites if grassland is used. Costs may be greater on E. tereticornis sites if mounding were required, and roads were to be raised . However wood production would be greater on E. deglupta sites. Plantation of this species would produce in 10 years the same quantity of wood as would be produced by E. tereticornis plantation in 15 years. Thus E. tereticornis would need to be planted 5 years earlier to achieve the same result, and hence would bear interest charges on establishment costs for the extra period. Moreover there are the additional costs of protecting the plantation from fire for the 5 year period. These costs may be important because fire protection costs in the coastal grassland would be high. These sites have less rain. Moreover they are usually fired by the local people in the dryer season. On the other hand transport costs would be far less for E. tereticornis chipwood as the prospective planting site is much nearer to the port.

It is difficult to select the better project without further analyses which are beyond the resources of this study. However a choice must be made. The plantation project has therefore

been based on E. deglupta plantation located on the ash soils to the north of Mount Lamington and the main road.

CHAPTER 6

OTHER PLANNING CONSIDERATIONS.

6.1 LOCAL AVAILABILITY OF RESOURCES.

6.1.1 Land and Labour.

There are extensive areas of forest and grassland in the area selected for the plantation project. These are only occasionally used for food gathering and hunting. The rights to the land are shifting and complex and it may not be possible to obtain a definitive list of right holders. However the control of residual land in lightly populated areas generally rests with the subclan, and decisions reached by this group on land matters are respected by all (see Chapter 3). Thus it should be possible to obtain and maintain rights to the use of the residual land by negotiating rents with the subclans as a group. In the area selected for the project most of the subclans have moved into large villages with the encouragement of past administrations and thus arrangement of meetings for the purposes of business discussion should not be difficult.

There should be no problem in obtaining the labour required because of the large pool of unemployed (see Chapter 3).

6.1.2 Availability of Local Capital.

Capital accumulation in villages in several areas of Papua New Guinea was investigated by Moulik (1973). The savings for three different societies studied by Moulik in 1972 are shown in Table 6.1.

Table 6.1 CASH INCOME AND EXPENDITURE OF VILLAGE HOUSEHOLDS IN DIFFERENT LOCALITIES OF PAPUA NEW GUINEA.

	Number of Household*	Average Consumption Units per Household	Income per Consumption Unit (K per month per C.U.)	Savings per consumption Unit (K per m. per C.U.)
Milne bay	23	5.5	2.4	0.48
Madang	19	4.8	4.3	1.18
Eastern Highlands	25	4.7	5.8	1.10

* An adult is considered to be one consumption unit.

A child is less than one.

Source : Moulik (1973).

Table 6.1 shows that the income per month per consumption unit was very low. Most income was spent. Cash cropping does not seem to have developed to any extent in these areas although they have had long contact with Government extension services. This suggest that demand for cash was satisfied at very low levels in these areas. The situation would be similar in the Northern District.

The way income was earned and spent in two Northern

District villages in 1962 which is shown in Table 6.2 is probably similar today.

Table 6.2 INCOME AND EXPENDITURE OF TWO VILLAGES IN THE NORTHERN DISTRICT.

	Inonda (1963)	Sevepe (1966)
	Income ($ per household per month)	
	5	2.3
	(percent)	
Paid labour	50	30
Cash cropping	15	20
Gifts	-	50
Miscellaneous *	35	-
	Expenditure ($ per household per month)	
	4.2	2.8
	(percent)	
Food and clothing	70	70
Social obligations	30	25
Miscellaneous	-	5

* The miscellaneous category would be mainly gifts and other social expenditure.

Source : Crocombe et al.(1963)
Rimoldi (1966)

Table 6.2 shows that a very low level of cash income was derived almost equally from paid labour or cash cropping, and from gifts. Expenditures were mainly for essential food and clothing with a substantial expenditure on social obligations.

Both sources report that capital accumulation was very small and most households retained very little cash (Moulik, 1973). The few bank accounts held were not used.

It seems certain that the capital to establish the Plantation Project must come from outside the local area in the first instance. It should be possible to arrange for local capital accumulation in bank accounts when local incomes begin to rise. It has been shown that village people have readily adopted the banking habit where facilities and training in their use have been provided.

6.1.3 Availability of Management Skills.

Considerable planning, administrative, and technological skills, are required to successfully establish and run a plantation project. Some ventures in this area based on familiar crops, and organized by expatriates with government advice, have failed (P.N.G. Central Planning Office, 1973). To avoid a further failure. it will be necessary to employ professional foresters, accountants, and technical staff, to run the project. These people are not available at the present time from the local areas, and would be recruited from elsewhere. The higher level positions may need to be filled with expatriates in the first instance because the indigenous people capable of running the project can not be spared at present. Indigenes now in training should be available in a few years.

6.2 LEGAL CONSIDERATIONS.

6.2.1 Forestry Plantation Tenure.

Land tenure has long been a major problem for the Government. The importance of secure land tenure for long term developments was recognized early, and great efforts were made by the Government to establish an effective land tenure system. However firm and lasting agreements on land between the Government and the business community on the one hand, and the village people on the other, has been the exception rather than the rule in Papua New Guinea. Schemes apparently accepted by village people at one time have been ignored when later they came to need the land.

The string of Land legislation reflects past effort to find a suitable legal formula. All the Land Ordinances have failed to a greater or lesser extent, mainly because of the persistent attempts to impose the western concept of individual freehold. This was believed to be a pre-requisite of efficient agricultural endeavour. Past legislation includes :

(a) The Real Property Ordinance 1913-1955, and the Land Registration Ordinance 1923-1955.

(b) The Native land Registration Ordinance 1952 which was based on English land law. No land reached registration under this ordinance.

(c) The Land Registration (Communually Owned Land) Ordinance 1962, which was modelled on the Fijian Land Tenure legislation and had a mechanism for registration of customary land titles. There was much registration and demarcation under this ordinance often without survey.

The Ordinance rapidly fell into disrepute because it was used in practice to register individual title. Also because many feared the long term consequences of the widespread practice of demarcation without survey.

(d) The Land Tenure Conversion Ordinance 1963-67 was a response to pressure from the Department of Agriculture for legislation to facilitate conversion to individual title. The legislation provided a process for conversion of customary land tenure to Torrens title, and then to individual title. The scheme proved popular in the Northern District which was used as a trial area. By December 1965 there were 34 land tenure schemes under way covering 13,426 hectares (Morawetz 1967). However these were limited to unpopulated areas. The Ordinance was not continued because it proved very expensive to implement.

Throughout the period covered by this legislation there were disputes over land and in recent times these gradually spread. As a result the Government established a Land Titles Commission under the Land Titles Commission Ordinance 1962-67, to adjudicate land disputes. This body had limited success. It was not able under the Ordinance to give official recognition to the fact that village people often did not understand or recognize the validity of the western concepts embodied in the legislation.

As self Government approached the solution of land tenure problems became more urgent. By the early 1970's many were questioning the basic assumptions that individualization of land was

necessary, and that western concepts of ownership were appropriate (Simpson, 1971). Simpson (1971) proposed a new uniform and simple code which recognized the realities of the cultural setting. His main propositions received some support. The system he proposed was based on the system used in Kenya and included :

(a) Absolute ownership of land to rest with the group.

(b) Registration procedures to be simply local registration of a list of those with an interest in land.

(c) Rights within the group to be subject to customary law.

(d) Provision for groups to create registerable rights over the land and to transfer these to others within or without the group.

(e) The rate of alieniation and the policing of rights held by outsiders to be subject to government control.

Under this system the distribution and control of rights is placed in the hands of the only group who can exercise effective control in practice, the local people. Furthermore it minimizes the need for demarcation, and it opens the way for conversion to a more formal system of title at a pace which suits the particular locality. No action was taken on these proposals at the time. However in 1973 the Papua New Guinea Commission of Enquiry into Land Matters was established with the major purpose to discover ways to overcome a shortage of land for development purposes, and this Commission gave public support to the idea of group rights. Perhaps as a result the concept was incorporated in the policy of the first indigenous government at the time of

independence (P.N.G. Central Planning Office, 1973).

It is expected that Land legislation will soon be changed to accomodate the concept of group rights, if the change has not already occured. Thus it is important that the plantation project be planned on the basis of land boundaries based on traditional group rights.

6.2.2 Tree Tenure.

Respect by local people of group rights to the trees will be important to the project, however there is evidence that the security of the trees will not be a problem. It was noted in Chapter 3 that individuals recognized ownership of trees by others irrespective of where these grew. It seems this respect extends to cash crop plantings. For example Rimoldi (1966) reported that continuous planting and tapping of rubber tree has been performed in the Sevepe area by individuals from outside the land-holding group. When land becomes scarce it is possible this traditional respect for rights to trees may weaken. Thus it seems sensible to invest rights to the trees in the indigenous group as a whole if at all possible. This should reinforce the social pressure on the individual to respect the common ownership.

6.2.3 Commercial Law.

At the time of independance the Commercial Law of Papua New Guinea was basically the same as that in Australia. It was designed to provide protection to holders of equity and the public in general, in a relatively modern economy. The range of legal commercial institutions was in 1969 essentially limited to the

following :

(a) Associations, a form of organization for groups working for a particular cause, where profits of enterprize were devoted to the aims of the association and not to members.

(b) Partnerships, where a maximum of 20 people shared the equity.

(c) Cooperatives of several types, including primary societies serving members directly, in which any number of adults could participate, there was no provision for inputs from outside except in the form of loans and advice. There were also secondary societies which could serve a group of societies, particularly in the management of funds.

(d) Proprietary companies where equity was limited to a particular group and

(e) Public companies with freely transferable equity, but with extensive legal requirements on maintenance of records and the provision of information to the Government and the public.

Source : Healy (1969).

More recently there have been changes in the legislation. The P.N.G. Central Planning Office (1975) reported a new Business Group Incorporation Act which allows legal recognition of traditionally based groups as a business entity. It is not known whether traditional groups could share equity with outside interests under this legislation.

6.3 SOCIAL CONSIDERATIONS.

6.3.1 Co-operation of the Local People.

Real authority in rurual areas rests with group meetings and the individual household heads. Group meetings of household heads and other members of the community are frequently held to discuss issues of common concern. The scope of attendance depends on the issue and may range from the hamlet to the tribe. At such meetings there are no leaders in the western sense. Nevertheless elders who are the oldest men of the group, and "big" men who are men who have built a reputation for active contribution to social activities, often have more influence. Everyone is free to speak and they frequently do so. Explicit decisions are seldom reached. Individual household heads are free to monitor the popular will, and then make their own decision keeping the consequences in mind. Customary law and the will of the majority is generally imposed through social sanctions. These sanctions are particularly successful in a society which places such great store on social acceptance and prestige.

The reason for a meeting is often friction between individuals of the group, or between groups, and more often than not the friction relates to the question of land rights. Where agreement does not follow the meeting there may be an escalation of hostility, sometimes followed by an outburst of violence and occasionally the death of one or more of the antagonists. Alternatively sorcery is practised and this is greatly feared. Although the nature of sorcery is hard to define its influence is widespread. People often avoid particular localities, and occasionally move from one locality to another to avoid it. The environment for

the continuation of sorcery is provided by widespread ill health. These alternative mechanisms for settling disputes are undesirable, and every effort would need to be made to use meetings to reach general agreements.

The expatriate administration was the first outside body to exercise influence within local groups and this influence was often exercised through local meetings. The influence exercised was based on respect for the expatriate administration. This respect stemmed from effective pacification of the area by the Administration. Raids by war parties had previously been the bane of these people. The degree of influence in a particular village depended on the behavior of the local expatriate officers.

In recent years this form of external influence has waned. The main reason has been the increased assertiveness of the village people as independence approached and education increased. In addition, local "big men" have become far more influential because their prestige has been bolstered by aquisition of positions at district and national level. Today it is very difficult for a Government officer to direct or even influence activities of villages, particularly if the officer is an indigene. It will be imperative for the success of a plantation project that government and company officers make an early effort to win respect in the local community. The village meeting will provide the main forum for the exercise of influence. These meetings may be the only effective means of winning long term co-operation from the local people.

6.3.2 Motivation of Labour.

Success of the project will depend on the motivation of considerable numbers of local people. In the past motivation of labour has been low. Many entrepreneurs believed the local people were naturally lazy. However this does not seem to be the case on close examination.

In the past very low wages were paid. Moreover indigenes were frequently required to work for nothing on social projects which the Government or a church deemed to be important for their welfare. In addition the general health of workers was poor. Crocombe et al.(1963) found that residents at Inonda lost one day in ten from sicknesses, including malaria, gastro enteritus, filariosus and influenza, and men were further weakened by the loss of sleep due to cold night-time conditions. Indigenes who engaged in cash cropping were often discouraged by price failures which resulted from price changes in the world market (Rimoldi 1966; Dakeyne, 1966; Moulik 1973). Indigenes were not in a position to understand such changes.

It is now believed by some that the apparent lack of enthusiasm for work reflects the value system of the people. Moulik (1973) studied two villages in the Milne Bay area which had long been exposed to expatriate culture. He performed a survey to establish the attributes which conferred status in these villages. The results of the survey are shown in Table 6.3.

Table 6.3 MOST FREQUENTLY CHOSEN STATUS CHARACTERISTIC OF A VILLAGE IN THE MILNE BAY DISTRICT.

	Replies (percent)
Rich in traditional wealth	63
Older in age	49
Land controlled	41
Large family size	36
Knowledge of clan history	32
Good speaker	18
Rich in modern wealth	17
Knowledge of sorcery	11
Modern education	9
Good fighter	2

Source : Moulik (1973).

Table 6.3 shows that status was largely determined by traditional wealth, gardens, pigs, shells, feathers and land, and by age. Otherwise family size and knowledge of the clan history were important. Monetary wealth and modern education were of relatively little importance.

On this basis Moulik (1973) developed the thesis that status was largely determined by the degree to which individuals contributed to the maintenance and development of the traditional social life style of the village people. The thesis of Moulik explained the high priority attached by the indigene to any responsibility the individual had to the group. It also explained

the ostentatious spending on village feasts and other activities of ambitious people who had aquired some monetary wealth. In the absence of such charity these individuals were frequently regarded as socially deviant and were sometimes ostrasized (Moulik (1973). Furthermore it explained the values placed on time by people in the Northern District. Crocombe et al.(1963) found a strict hierarchy in the allocation of time among Inonda villagers. Social obligations took precedence over subsistance agriculture, and obligatory work for church and council took precedence over cash cropping. The exceptions were for sickness, and in the case of young men, for sufficient paid work to obtain money to provide a bride price. The situation is much the same today hence it is not surprizing that the demand for cash is low, and is generally limited to that required for trade store essentials and for social obligations. It seems that money is not regarded by the indigene as an object, but rather as a means to obtain the minor possessions necessary for the continuation of a satisfying life style.

Moulik (1973) believed that because motivation levels were related to the value system it might be several generations before the basic attitudes to work and money could be changed. I believe this is not inevitable. Sustained motivation of labour is possible if the basic drive of the individual to aquire status through contribution to the group is recognized and used. Plantation labour would be motivated if the project were presented as a joint entreprize of the subclan group in competition with other groups, and as a means by which individuals might make a social contribution to their group.

The details of a plantation project based on these considerations is presented in the next chapter.

CHAPTER 7

FORESTRY PLANTATION PROJECT.

The project involves establishment of E. deglupta plantations on grassland and cleared rainforest sites in the general area of the Saiho Forest. A private company would establish and manage the plantations. Chipwood would later be sold at the stump to a Logging Company for sale to the chipmill.

7.1 THE PLANTATION OWNING COMPANY.

A proprietary company is proposed. Some form of special provision for the progressive transfer of equity with time to members of subclans involved in establishing the project is assumed. Authorized capital is assumed to be 40% of funds required, provided in equal parts by the Investment Corporation of Papua New Guinea, which generally acts as the Government agent in the purchase of equity in private enterprize, (P.N.G. Planning Office, 1975), and by the Logging Company. The remaining 60% of funds is assumed to be borrowed from the Development Bank of Papua New Guinea, which is authorized by the Government to act as a lender of last resort to development projects which are in the national interest.

As time passes the local people will be given the opportunity to use wages and rent earned from the development to buy the equity held by the Investment Corporation. The proportion of funds borrowed from the Development Bank would decline progressively as the proportion of planting on new sites declines. Thus in the

middle to long term the company would be owned and run by the local people and the Logging Company in partnership.

The Board of the company is assumed to consist of Investment Corporation and Development Bank officers, who also represent the Government interest, Logging Company representatives, and representatives of the local subclans involved in the project.

7.2 PLANTATION LAND AND LABOUR ARRANGEMENTS.

Plantations would be established at a rate sufficient to provide the planned requirements of a chip mill. Rather than one large plantation it is proposed that several discrete plantations be used, each within the borders of the relatively little used land of a single subclan. The size of the block would be limited so that the subclan can provide all the labour required with minimal interference to subsistance and cash cropping. The aim would be to utilize part of the abundant leisure time of these people. The number of plantations, their specific location, and the particular site type used, would be determined to some extent by the pattern of rainforest logging operations.

Land for a particular plantation would be rented from a subclan after negotiation with the group as a whole, and the rent would be paid to the subclan bank account. The rent would be subject to periodic renegotiation. Encouragement would be given to the subclan to use rent money to purchase equity in the Plantation Company from the Investment Corporation.

Agreements on labour hire would be made at meetings of the subclan concerned. Such agreements might cover the contribu-

tion to be provided by particular kinship groups for particular operations. It would be left to lower level supervizors, on the staff of the plantation company, but employed from the particular subclan, to organize the contribution of labour by individuals from each kinship group. If particular individuals or kinship groups do not participate,their behavior would be drawn to the attention of the subclan at the next meeting and this should encourage their participation. Payments for labour would be made into kinship group bank accounts, and encouragement would be given to individuals to use this money to purchase equity in the Plantation Company from the Investment Corporation.

These arrangements would be compatible with Government intention in the field of legislation (see Chapter 6). If the proposed arrangement is not entirely legal under present legislation, only minor rearrangement should be necessary. The arrangements also ensure there would be minimal disturbance to the indigenous life style as the project develops,because employment would be offered in proportion to the leisure time of the local individuals, and the customary social organization would not only be retained but strengthened, especially in regard to the distribution of power and decision making. Moreover provision would be made to allow the local people to obtain equity in the enterprize as rapidly as possible. Furthermore new employment would be created in the localities and at the time it is most needed.

The scheme would be designed to obtain the co-operation of the groups as a whole but it should benefit individuals as well. Individuals and kinship groups would have a particular plantation with which they can identity. Also a new means of winning social

prestige by contribution to the larger group. This should increase the individual satisfaction. Moreover there would be the further individual satisfactions of obtaining employment, income, equity, and taking part in business decisions. At the same time there would be little interference to the individuals usual activities. Compulsion of the individual would be avoided and the individual would retain freedom within limits to choose when his labour is committed. Moreover the individuals land rights and his freedom to conduct his social life and subsistance agriculture would be retained. Only relatively useless group land would be planted.

The element of competition between subclans introduced by planning seperate plantations should strengthen the motivation of subclan groups. Care should be taken to avoid pairing plantations of subclans of adjacent tribes which would stir up old emnities.

7.3 PLANTATION ESTABLISHMENT AND MAINTENANCE OPERATIONS.

The proposed schedules of plantation establishment are shown in Table 7.1a and Table 7.1b.

Table 7.1 SCHEDULES OF PLANTATION ESTABLISHMENT (hectares).

(a) Plantation Establishment by Locality.

Year	Urarisusu			Hujavasusu			Divinikaiari			Ungona			Korapata			Sui		
	G*	RF	RP	G	RF	RP	G	RF	RP	G	RF	RP	G	RF	RP	G	RF	RP
1																		
2	-	-		-														
3	200			200														
4	200			200														
5	224			224														
6	224			224														
7	224			224														
8	224			224														
9	224			224														
10	224			224			-	-		-	-							
11	242			242				128			128							
12	242			242				128			128							
13	242		-	242	-	-		128			128							
14	42		200	42	200	200		128			128							
15	42		224	42		224		128			128		-	-		-	-	
16	18		224	18		224		242			242			110			110	
17	18		224	18		224		242			242			242			242	
18	18		224	18		224		242			242			242			242	
19	-		242	-		242		242			242			242			242	
20			242			242		242			242			242			242	
21			242			242		242	-		242	-		242			242	
22			242			242		114	128		114	128		242			242	
23			242			242		114	128		114	128		242			242	
24			242			242		114	128		114	128		242			242	
25			242			242		114	128		114	128		242			242	
26			242			242		114	128		114	128		242	-		242	-
27			242			242		-	242		-	242		132	110		132	110
28**			242			242			242			242		-	242		-	242

* G represents a grassland site

RF represents a cleared rainforest site

FP represents a replanting

** Beyond year 28 annual costs remain unchanged.

Table 7.1 (cont.)

(b) Plantation Establishment by Site Type.

Year	Grassland	Cleared Rainforest	Replanting	Total
1				
2	-			-
3	400			400
4	400			400
5	448			448
6	448			448
7	448			448
8	484			484
9	484			484
10	484	-		484
11	484	256		740
12	484	256		740
13	484	256	-	740
14	84	256	400	740
15	84	256	400	740
16	36	704	448	1,188
17	36	968	448	1,452
18	36	968	448	1,452
19	-	968	484	1,452
20		968	484	1,452
21		968	484	1,452
22		712	740	1,452
23		712	740	1,452
24		712	740	1,452
25		712	740	1,452
26		712	740	1,452
27		712	1,232	1,452
28*		-	1,452	1,452

* G. represents a grassland site
RF represents a cleared rainforest site
RP represents a replanting

The 6 plantations shown in Table 7.1a would be located near the villages of Urarisusu, Hujavasusu, Divinikaiairi, Ungona, Korapata and Sui which lie to the north and south of the Saiho forest area (see Map No. 1(1)). The first pair of plantations would be progressively established at Urarisusu and Hujavasusu to the north of the Saiho area in grassland. The people here would be most in need of employment opportunities in the early years before rainforest logging has reached this area. A grassland site was selected because cleared rainforest is not available. Chipwood would be available from this area by year 10.

A second pair of plantation would be established at Divinikaiari and Ungona from year 11 on rainforest sites. By year 11 rainforest logging would terminate in the immediate area and alternative employment would be required. These plantations would be established on rainforest sites. This seems sensible and it has the added advantage that it would provide a comparison of costs between site types in the analyses. The siting of these plantations could be altered if this were warranted by financial considerations. A third pair of plantations would be started in year 16 at Korapata and Sui on rainforest site cleared in the preceeding years. Employment would be needed in this area at about year 16 to compensate for the cessation of logging. Cleared rainforest sites would be used because there is probably insufficient grassland to accomodate much of the plantations planned.

On all sites plantations would be re-established in the year following clearfelling. It is anticipated plantations could be continued for several rotations without lowering the fertility of these rich soils.

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(1) See Appendix E

Table 7.1b shows that cleared rainforest would become the site type most used for new planting by year 14, and considerable areas of this site type would be planted from year 16 to year 27. A stable maximum rate of plantation establishment of 1,450 ha per annum would be reached by year 17. By year 28 the plantations would have reached a stable size of 14,520 ha.

Figure 7.1 shows the scheduling of annual operations that were estimated to be required for the establishment of the plantations on the different sites. The selection of operations was based on personal experience and discussion with foresters with experience in these situations. The key operation is planting. Its timing was determined by the rainfall distribution shown in Figure 5.1. The Saiho area lies between Buna and Ioma and can be expected to have an intermediate rainfall pattern. The wettest period begins with the S.E. monsoon in November, and mean monthly rainfall remains high until March. Mean monthly rainfall then declines to low levels from June to September. Nevertheless mean monthly rainfall does not fall below 12 cm in any month. Thus the planting season was assumed to begin in November and to finish in February. Survey, roading, and site preparation were assumed to precede planting as closely as possible.

It was assumed that grassland sites would be ploughed twice to obtain control of the site. Ploughing would precede and follow planting. It was also assumed the sites would be sown to Styloanthus a fast spreading legume after the second ploughing to smother weed growth. Subsequent tends would be relatively light, and in general aimed at freeing the young trees from the legume. It was further assumed a formed earth road network would be esta-

Site Type and Operation	Month										
	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Grassland												
Year 1 Survey					—							
Plough/road					—	—	—					
Plant						—	—	—	—			
Cross plough/									—	—		
Sow legume												
Year 2												
Tend 1(a)			—	—								
Tend 2(a)											—	—
Clear Felled Lowland Rainforest												
Year 1												
Survey					—							
Heap/burn/				—	—	—	—	—	—			
Road/poison												
Plant						—	—	—	—	—		
Tend 1(b)										—	—	
Year 2												
Tend 2(b)			—	—								
Tend 3(b)											—	—
Replanting												
Year 1												
Heap/burn/					—	—	—	—				
Rip plant line												
Plant/sow/stylo						—	—	—	—			
Year 2												
Tend 1(c)			—	—								
Tend 2(c)											—	—

Figure 7.1 Temporal arrangement of plantation establishment operations.

blished while the heavy equipment is in the area.

It was assumed site preparation of lowland rainforest would closely follow final logging. Site preparation would involve poisoning of the remaining stems, and heaping and burning of logging debris. Sites which cannot be planted immediately would be sown to Styloanthus. The network of logging road should be adequate for the planting operation. Any relocation would be done while the tractors are in the area for heaping and burning. Tending performed in the first and second years on these sites would be more labour intensive than that on grassland sites.

Clear felled plantation sites would be covered with tree heads, but would otherwise be relatively weed free. It was assumed that the heads would be heaped and burned, that new planting lines would be ripped between the old lines, and that sowing to Styloanthus would follow planting.

Establishment and maintenance of firebreaks and fire fighting would be the only other operations to year 9, when the Logging Company would begin construction of the road network. The plantation was assumed to be divided into 500m x 500m blocks (see Appendix A). A 4 metres strip would be ploughed around each block, and 2 x 4 metre strips would be ploughed around each plantation , each year. The boundary strips would be spaced and the area between would be burnt.

The central nursery was assumed to be constructed at Serembi (see Map No.1(2)) in year 3. This nursery would provide all plants in subsequent years. Details of production and some details of the assumptions made with regard to the productivity of machinery are shown in Appendix A.

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(2) See Appendix E

7.4 PLANTATION INPUTS.

Based on the proposed project outlined in previous sections, estimates have been prepared of the inputs required. The estimates are classified into land, unskilled labour, staff, machinery and vehicles, buildings, and minor equipment and supplies.

7.4.1 Land.

Land is required for plantations shown in Table 7.1a and Table 7.1b. There is a considerable area of little used land in the selected localities and it should not be difficult to rent the areas required (see Map No.1(3)). Land is also required in the vicinity of Serembi for a nursery, office store and aid complex, and some housing for auxilliary staff.

7.4.2 Labour.

The estimated labour requirement for plantation establishment is shown in Table 7.2. The estimated requirements per hectare are shown in Table 7.2a and the total estimates are shown in Table 7.2b. The latter are based in part on the work of White (1975) and in part on personal experience and discussion with foresters with relevant experience.

Table 7.2a shows that the demand for labour from each of seven subclans is approximately 3,000 man days per year when the plantation operations stabilize in later years. The higher demand for labour in early years coincides with substantial planting of rainforest sites.

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(3) See Appendix E

Table 7.2 LABOUR REQUIREMENT FOR THE PLANTATION PROJECT.

(a) Labour by Locality (man days per annum)

Year	Urarisusu	Hujavasusu	Divinikaiari	Ungona	Korapata	Sui	Serembi
1							
2	-	-					-
3	1,460	1,460					960
4	2,660	2,660					960
5	2,835	2,835					960
6	2,979	2,979					960
7	2,979	2,979					960
8	3,111	3,111					1,200
9	3,219	3,219					1,200
10	3,219	3,219	-	-			1,200
11	3,219	3,219	2,511	2,522			1,680
12	3,219	3,219	4,314	4,314			1,680
13	3,219	3,219	4,314	4,314			1,680
14	3,039	3,039	4,314	4,314			1,680
15	4,783	4,783	4,314	4,314	-	-	1,680
16	4,751	4,751	6,559	6,559	2,167	2,167	2,640
17	3,695	3,695	8,155	8,155	6,307	6,307	3,120
18	3,695	3,695	8,155	8,155	8,155	8,155	3,120
19	3,679	3,679	8,155	8,155	8,155	8,155	3,120
20	3,001	3,001	8,155	8,155	8,155	8,155	3,120
21	3,001	3,001	8,155	8,155	8,155	8,155	3,120
22	3,001	3,001	6,453	6,453	6,453	8,155	3,120
23	3,001	3,001	5,429	5,429	8,155	8,155	3,120
24	3,001	3,001	5,429	5,429	8,155	8,155	3,120
25	3,001	3,001	5,429	5,429	8,155	8,155	3,120
26	3,001	3,001	5,429	5,429	8,155	8,155	3,120
27	3,001	3,001	3,913	3,913	6,692	6,692	3,120
28	3,001	3,001	3,001	3,001	4,057	4,057	3,120
29*	3,001	3,001	3,001	3,001	3,001	3,001	3,120

* Beyond year 29 annual labour inputs remain unchanged.

Table 7.2 (cont.)

(b) Labour Requirement for each Operation (man days per ha.)

Operation	Site type		
	Grassland	Clearfelled Rainforest	Clearfelled Plantation
Survey	0.1	1.0	-
Tractor assistance			
Plough & road	0.2		
Crossplough/saw stylo	1.0	-	
Heap/burn/heap/road	-	2.0	-
Ripping plant line	-	-	2.0
Poison	-	0.5	-
Burn	-	-	0.2
Plant	6.0	8.0	6.0
Tend			
No. 1	3.0	10.0	3.0
No. 2	3.0	8.0	3.0
No. 3	-	6.0	-
Total labour			
Year 1	7.3	19.7	6.4
Year 2	6.0	14.0	6.0

It seems from Table 7.2b that the labour required to establish plantation on cleared rainforest is 2.5 times that required for the other site types. For all sites most of the labour is used on planting and tending. Moreover the demand for labour is not distributed uniformly throughout the year, but is concentrated during periods of planting and tending. On grassland and replanting sites the peak demand for labour is between November and February when approximately 50% of the annual labour is used. On cleared rainforest sites the peak occurs in March and April when approximately 30% of the annual labour is used. Peak levels of demand for labour are shown in Table 7.3.

Table 7.3 PEAK DEMAND FOR LABOUR BY LOCALITY AND YEAR.*
(man months per month).

Year	Locality			
	Urarisusu & Hujavasusu	Divinikaiari & Ungona	Korapata & Sui	Serembi
15 to 16	30			
17 to 21		61		
18 to 26			61	
17 to				13

* It is assumed there are 20 working days per month.

Table 7.3 shows that the peak labour requirement for Divinikaiari, Ungona, Korapata and Sui is 61 labourers. This labour force is required for 2 months of the year when planting

cleared rainforest is at a peak. In the Urarisusu and Hujavasusu plantations peak demand for labour is just half this level, but is required for a period of 4 months.

7.4.3 Staff.

Table 7.4 shows the staff complement each year.

The estimates in Table 7.4 were based on those of White (1975) adjusted for the planting rate. Professional staff positions are filled from the outset. These include an Officer in Charge, and a Level 3 supervizor, both expatriate foresters. Also an accountant. The Level 3 supervizor and the Officer in Charge are replaced by indigenes in year 9 and year 3 respectively. Lower level staff are added at the time planting is extended to new areas.

Table 7.4 PLANTATION PROJECT STAFF.

Staff Category	Year															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 **
General																
O.I.C. (E)*	-	-	1	1	1	1	1	1	1	1	1	1	-	-	-	-
O.I.C. (I)*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1
Accountant (I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Payclerck(I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Typist (I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	2
Medical asst. (I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Carpenter (I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Capenters asst. (I)	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1
Driver (I)	-	-	1	1	2	2	2	2	2	2	3	3	3	3	3	3
Plantation																
L3* (E)	-	-	-	1	1	1	1	1	-							
L3 (I)		-	-	-	-	-	-	-	1	1	1	1	1	1	1	1
L2 (E)	-	-	½	-												
L2 (I)	-	-	2	2	2	2	2	2	2	2	4	4	4	4	4	6
L1 (I)	-	-	2	2	2	2	2	2	2	2	4	4	4	4	4	6
Nursery																
L2 (E)	-	-	½	1	-											
L2 (I)	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L1 (I)	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1

* E represents expatriate

I represents indigene.

L represents level of supervisor - 3 is highest the level.

** Beyond year 16 staff and other skilled personal numbers are unchanged.

7.4.4 Vehicles and Machinery.

7.4.4.1 Hired machinery.

Heavy machinery is used for limited periods each year. Thus it is more economical to hire this equipment from the Logging Company and avoid idle time. With this arrangement there is no need to construct a large service and repair workshop.

Table 7.5 shows the estimates of heavy machinery required to establish and maintain a hectares of plantation on different site types. These estimates were based on the experience of the author and an experienced forester (McCarthy pers. comm.). Some specifications of the equipment are shown in Appendix A. Machine hire time consists largely of tractor hire time which is shown in Table 7.6. Details of grader hire time are shown in Appendix A.

Table 7.5 shows the considerable difference in the tractor time required for establishment on the different site types. The heavy requirements for tractor time in later years which are shown in Table 7.6 are a result of this. Tractor hire associated with clearing and ripping on replanting sites is also substantial. The estimated tractor time for fire break establishment and maintenance is relatively small by comparison.

Table 7.5 HEAVY MACHINERY HIRE (hours per hectare).

Operation	Machine	Site type		
		Grass-land	Clear-felled Rain-forest	Clear-felled Planta-tion
Road Construction	Crawler tractor	0.010	-	-
	Grader	0.005	-	-
Road maintenance	Grader*	0.005	0.005	0.005
Fire break Estbl. & Maintenance	Crawler tractor*	0.01	0.01	0.01
Ploughing and Cross ploughing	Crawler tractor	0.67	-	-
Heap/burn/heap	Crawler tractor	-	3.20	(?)
Rip planting line	Crawler tractor	-	-	1.34
Totals for Establ.	Crawler tractor	0.68	3.20	1.34
	Grader	0.005	-	-

* Annual requirements.

Table 7.6 TRACTOR HIRE (hours)

Year	Plantation Establishment			Fire Break Establishment & Maintenance	Total
	Grassland Area	Rainforest Area	Replant. Area		
11					
2	-			-	-
3	540			4	544
4	540			8	548
5	605			12	617
6	605			17	622
7	605			21	626
8	653			26	679
9	653			31	684
10	653	-		36	689
11	653	819		43	1,515
12	653	819		51	1,523
13	653	819	-	54	1,526
14	113	819	804	58	1,794
15	113	819	804	61	1,797
16	49	2,253	901	68	3,271
17	49	3,098	901	76	4,124
18	49	3,098	901	85	4,133
19	-	3,098	972	95	4,165
20		3,098	972	105	4,175
21		3,098	972	112	4,182
22		2,278	1,487	119	3,884
23		2,278	1,487	126	3,891
24		2,278	1,487	133	3,898
25		2,278	1,487	140	3,905
26		2,278	1,487	145	3,910
27		704	2,476	145	3,325
28*		-	2,918	145	3,063*

* Beyond year 28 annual tractor time remains unchanged.

7.4.4.2 Other Vehicles and Other Machinery.

Table 7.7 shows estimates of the major equipment owned and operated by the Plantation Company.

The estimates shown in Table 7.7 were based on White (1975) adjusted for scale. Some equipment specifications are shown in Appendix A. A station sedan is provided for the O.I.C. and the Company accountant. Motorcycles are provided for the works supervizor in each plantation, with an additional motorcycle for office staff. This equipment should ensure staff mobility. Three utility vehicles provide transport for the plantation supervizors, and for equipment, supplies and labour. Transport of labour would be limited. Most labourers would live near their place of work. A water tanker is provided in year 5 at the time of establishment of the communication network and the first fire tower. An agricultural tractor and plant carrier are provided in year 16 to free utilities for other work during the planting season.

7.4.5 Plantation Company Buildings.

Table 7.8 shows estimates of the buildings constructed and maintained by the Plantation Company. The office and nursery complexes are established in year 3. Standard 1 housing is provided for the expatriates and professional staff. Standard 2 housing is provided for lower level staff who do not live in the surrounding area, as required. The provision shown was based on assumptions of the sex and marital status of employees. These assumptions are shown in Appendix A. One fire tower is constructed in the third year of planting within the boundaries of each pair of plantations.

Table 7.7 PLANTATION COMPANY VEHICLES AND MACHINERY.

Type and Area of Operation	Year															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*
Administration																
Station Sedan	-	-	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Utility	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Motorcycle	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Plantation																
Station Sedan	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1
Utility	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Motorcycle	-	-	2	2	2	2	2	2	2	2	4	4	4	4	4	6
Agri. Tractor	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1
Plant carrier	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1
Disc. plough	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Protection																
Water carrier	-	-	-	-	1	1	1	1	1	1	1	1	1	1	1	1
Nursery																
Utility	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Motorcycle	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1

* Beyond year 16 number of vehicles used remains unchanged.

Table 7.8 PLANTATION PROJECT BUILDINGS.

Type of Building	Year																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18*
Administration																		
Office Complex	-	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Housing Std 1.	-	-	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Std 2.	-	-	4	4	5	5	5	5	5	5	7	7	7	7	7	9	9	9
Plantations																		
Housing Std 1.	-	-	½	½	1	1	1	2**	1	1	1	1	1	1	1	1	1	1
Std 2.			1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3
Protection																		
Fire tower	-	-	-	-	1	1	1	1	1	1	1	1	2	2	2	2	2	3
Nursery																		
Tubing Complex	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Housing Std 1.	-	-	½	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Std 2.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

* Beyond year 18 number of buildings used remain unchanged.

** Extra house because 2 x L3 supervisors are engaged in year 8.

7.4.6 Other Inputs.

Other inputs include :

(a) Office equipment

(b) Communications equipment, including a radio at base, in each fire tower, and in the vehicles of senior personel.

(c) Supplies for nurseries for plantation establishment and for protection purposes.

(d) Stationary and

(e) Petrol oil and lubricants.

These categories of input are less significant than those mentioned previously and have not been itemized. Their volume is indicated by cost data in Appendix C. Petrol oil and lubricants were estimated seperately for each vehicle (see Appendix C).

CHAPTER 8

PLANTATION REVENUES

Estimation of plantation revenues is an essential preliminary step to the financial and social analyses of the plantation project. Revenues would be obtained from sales of chipwood to a Logging Company at the stump. The price for such material is not available. However the price that might be offered can be estimated. The estimated value of E. deglupta chipwood at the stump was based on the estimated chipmill door value of mixed tropical hardwood chips at Madang. The estimate for stumpage was obtained by making suitable adjustments to account the likely costs incurred in the harvesting and transport operation.

In Section 8.1 Section 8.2 and Section 8.3 the value of E. deglupta wood at the chipmill door was estimated on the basis of a comparison with the value of mixed temperate eucalypt chip S.E. Australia by means of a procedure developed by Phillips and Logan (1977). The procedure was not published until the project evaluation was well advanced, hence the estimate for mill door value derived in this way was not used in the calculations found in in later chapters.

All calculations were made at constant prices as at December 1976. Where necessary the C.P.I. (see Appendix A) was used to update prices.

8.1 VALUE OF CHIPWOOD AT THE PULP MILL DOOR.

The value of chipwood per B.D.U. (1) is determined to a large extent by the yield from the pulping process and the basic density of the wood. The physical structure of the chipwood is of much less importance. This is evident from the economic analysis of Phillips et al. (1977). Basic density is important because it largely affects bulk and therefore the weight carrying capacity of chip carriers. On the other hand wood of high basic density usually has high extractive content and a relatively low yield (Higgins et al. 1973). The physical structure or the chemical composition of wood may render it unsuitable for pulping but this is not the case with E. deglupta (Davidson, 1973b).

Table 8.1 shows the yield and basic density of chip samples of E. deglupta, Eucalyptus regnans F.v.M., and a representative sample of mixed tropical hardwood chips from Vanimo in Papua New Guinea, reported by Higgins et al. (1973). The kappa number shown is an index of the extrative content of the pulp. It seems from Table 8.1 that E. regnans may be the most valuable of the 3 types of chip in terms of B.D.U. of wood at the mill door. E regnans

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(1) B.D.U. represents bone dry unit. A bone dry unit is defined as 2400 lbs of bone dry wood (see Dohne, J., and Wright, D.M., (1975). Conversion factors for the Forests Products Industry in Western Canada. Environment Canada, Forestry Directorate, Western Forest Products Laboratory, Information Report BP- X -97.

wood seems reasonably uniform, has a relatively high basic density, a relatively low extractive content, and a high yield of pulp. Mixed tropical hardwood chip has a lower basic density, higher and less uniform levels of extractives and lower yields, and hence

Table 8.1 BASIC DENSITY AND PULP YIELD FOR EUCALYPTUS DEGLUPTA, EUCALYPTUS REGNANS, AND MIXED TROPICAL HARDWOOD CHIPS.

Sample	Basic Density (kg/m3 o.d.w.)	Kappa* Number	Pulp wood Yield ratio (g.o.d. pulp per 100 g.o.d.. wood**
Eucalyptus deglupta			
P.N.G.	307	22.5	49.9
		12.5	44.3
Young P.N.G.	364	46.6	52.7
		26.9	50.1
		17.1	47.7
Eucalyptus regnans			
age 9-13 (years)	426	13.4	52.4
representative sample	442	15.0	53.8
age 12 (years)	46	17.7	51.0
Mixed tropical hardwood			
(representative of one block	498	41.0	50.9
Vanimo P.N.G.)	498	21.0	46.9

* Kappa number is an index of pulp extrative content.

** Yields refered to are from the kraft process. They are not necessarily representative of the species.

g.o.d. represents gram oven dry.

Source : Higgins et al. 1973.

would be less valuable on a B.D.U. basis. E. deglupta shows great variability in both yield and extractive content, The young E. deglupta seems to have a comparable range of extractive content and yield to that of the mixed tropical hardwood but a lower basic density and this suggests E. deglupta chips may have similar value per B.D.U. except for the saving to be made on shipping denser material. However considerable doubt exists as to whether the samples of E. deglupta referred to in Table 8.1 are representative. For example Bolza and Kloot (1966) estimated the basic density of E. deglupta to be 557 kg per m3 (o.d.w.).

8.2 VALUE OF CHIPS F.O.B. NORTH COAST PAPUA NEW GUINEA.

The procedure developed by Phillips et al. (1977) for estimating the value of mixed tropical hardwood chips f.o.b. Vanimo Papua New Guinea was based on estimates of the value of mixed temperate eucalypt chips, f.o.b. S.E. Australia, and c.i.f. Japan ports, and allows for adjustments for freight, pulp yield, pulp quality and processing costs. Since a reliable estimate of a representative basic density of E. deglupta was not available the procedure followed was to apply the procedure twice using two different sets of assumptions. The first set of assumptions were that E. deglupta chips have a basic density of 364 kg per m3 (o.d.w.) and that in all respects relevant to pulping are similar to the mixed tropical hardwood chips referred to by Phillips et al. (1977) in their economic calculations. The first assumption is probably conservative whilst the second seems reasonable. The second set

of assumptions were that E. deglupta chips have a basic density of 557 kg per m3 (o.d.w.) and that in all respects relevant to pulping are similar to mixed tropical hardwood chips referred to Phillips et al. (1977) in their economic calculations. In this case both assumptions are probably optomistic. Wood of E. deglupta with a relatively high density might be excepted to have more extractive content and a lower yield than that of the less dense mixed tropical hardwoods (2).

The value in $ per B.D.U. of mixed temperate eucalypt chip and mixed tropical hardwood chip f.o.b. N. Coast Papua New Guinea relative to mixed temperate eucalypt chip f.o.b. S.E. Australia estimated by Phillips et al. (1977) are shown by the adjustments in Table 8.2. This table also shows the estimated value of E. deglupta chip f.o.b. N. Coast Papua New Guinea in $ per B.D.U. under 2 sets of assumptions relative to the value of mixed temperate eucalypt chip f.o.b. S.E. Australia.

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(2) Recent information suggests that for young plantation grown E. deglupta a representative basic density is 400 kg per m3 approx., and that yield of unbleached sulphate pulp may be 50 g.o.d. pulp per 100 g.o.d. wood. (See Phillips, F.H. and Logan, A.F., (1976). Papua New Guinea hardwood : Future source of raw material for pulping and paper making. Appita 30(1)). It seems that the yield of pulp from E. deglupta chips is likely to be intermediate between that from E. regnans and mixed tropical hardwood and that basic density is rather closer to the more pessimistic estimate in the text. Using the method of Phillips et al. (1977) this suggests a likely chipmill door value for E. deglupta wood of approx. K6.4 per m3 (o.d.w.).

Table 8.2 ESTIMATED VALUE OF MIXED TEMPERATE EUCALYPT CHIP, MIXED TROPICAL HARDWOOD CHIP, AND EUCALYPTUS DEGLUPTA CHIP, F.O.B. N. COAST PAPUA NEW GUINEA, RELATIVE TO VALUE OF MIXED TEMPERATE EUCALYPT CHIP F.O.B. S.E. COAST AUSTRALIA.

Factors	Value Adjustments ($A per B.D.U.)			
	Mixed Temperate Eucalypt Chip	Mixed Tropical Hardwood Chip	Eucalyptus deglupta Chip	
Basic density assumed (kg per m3 (o.d.w.))	563	484	364	557
Wood quality for pulp	0	0	0	0
Freight costs	+ 8.6	+ 5(+6)	- 3	+ 8.4
Pulp yield	0	- 7	- 7	- 7
Pulp quality	0	- 1	- 1	- 1
Pulp processing costs	0	- 1(-2)	- 1(-2)	- 1(-2)
	+ 8.6	- 4	-12.5	- 1.1

Source : Based on work of Phillips et al. 1977.

The formula used to calculate the adjustments shown in Table 8.2 is shown in Appendix B. From Table 8.2 it seems likely the value of E. deglupta may be somewhere between $A(-)1.1 per B.D.U. and $A(-12.5) per B.D.U. less than that for mixed temperate eucalypt chips f.o.b. S.E. Australia.

Table 8.3 shows the estimated value of E. deglupta chip f.o.b. N. Coast P.N.G. for each of the two sets of assumptions, based on the estimate of the fair price for mixed temperate eucalypt

chips f.o.b. S.E. Australia used by Phillips et al.(1977). This estimate was $A35 to $A40 per B.D.U.

Table 8.3 ESTIMATED VALUE OF EUCALYPTUS DEGLUPTA CHIP F.O.B. NORTH COAST PAPUA NEW GUINEA.

Basic density assumed (kg per m3 (o.d.w.)).	Value ($A per B.D.U.)	Value (Kina per B.D.U.)*
557	33.9 to 37.9 (Av. 36.4)	32.04
364	22.5 to 27.5 (Av. 25.0)	22.01

* Exchange rate as at December 1976.

Source : Based on work of Phillips et al. (1977).

From Table 8.3 it seems the value of E. deglupta chip f.o.b. N. Coast P.N.G. may lie somewhere between K22.01 per B.D.U. and K32.04 per B.D.U. depending on the actual characteristics of E. deglupta wood. The average estimates are used in the following section.

8.3 VALUE OF CHIPWOOD AT CHIPMILL DOOR.

The mill door value of chipwood may be obtained by adjusting the f.o.b. value of wood chip for the cost of handling on board, losses to decay in the chip pile, costs and fibre losses incurred during chipping, debarking costs and losses dur to decay in logs.

The cost of debarking, chipping and handling on board of mixed tropical hardwood chip material at Madang is believed to be approximately K7.6 per B.D.U. (McCarthy, R.B., pers. comm.). The

mill at Oro Bay is similar to that at Madang. It would be of similar scale, and would also be located at the wharf. However it would have the advantages of a supply which is on average both more uniform and more thinly barked. Hence the costs of manufacture and handling E. deglupta chipwood are estimated to be K7.0 per B.D.U..

Allowing for the debarking processing and handling costs the value of E. deglupta at the mill door at Oro Bay is estimated as follows :

(a) Under the first set of assumptions in Section 8.2

$$\frac{22.01 - 7 *}{1089/364} \quad \text{or} \quad \text{K5.02 per m3}$$

(b) Under the second set of assumptions in Section 8.2

$$\frac{32.04 - 7}{1089/557} \quad \text{or} \quad \text{K12.81 per m3}$$

* There are 1089 kg o.d.w. per B.D.U.

Decay in the chipwood is not likely to be a significant source of loss with young plantation grown E. deglupta (Davidson, 1974). However fibre loss during processing and loss from decay in the chip pile have been estimated to be 9% (Parkes, E.D., pers. comm.)

Hence the final estimates for the value of E. deglupta chipwood at the chip mill door Oro Bay using the two sets of assumptions in Section 8.2 and the procedure of Phillips et al. (1977) are K4.56 per m3 and K11.65 per m3.

Estimates for the mill door value of E. deglupta chipwood of K14.52 per m3, and for the basic density of E. deglupta of 557 kg per m3 were used in subsequent calculations. The value estimate which was based on the estimated milldoor values of mixed tropical hardwood chips Madang of K14.52 per m3 (McCarthy, R.B., Pers.Comm.) and the basic density estimate which was based on Bolza et al. (1966) seemed the best estimates available at the time.

The work of Phillips et al. (1977) become available to the author after the analyses were completed. Had the estimates for value and basic density which were derived from this information and which appear much more reliable been used in the analyses, then the estimate for stumpage would be considerably reduced. The effect on the stumpage estimate of reducing the estimate for the mill door value of E. deglupta is likely to be offset in part if a reduced estimate for the basic density of E. deglupta is used. A likely estimate for the green weight of E. deglupta would then be substantially less than 1000 kg per m3 and estimated transport costs would be substantially reduced.

8.4 VALUE OF STUMPAGE AND THE FINANCIAL ANALYSIS OF THE LOGGING COMPANY.

8.4.1 Road Construction and Maintenance.

The road network for log transport from the rainforest will serve the plantation project as well. Only minor additions to the road network are required. These include the roads within the plantations. A model of the plantation roads is shown in Appendix A. Appendix B shows some details for each category of road to be discussed in this section. The major distinction between the categories is in the depth and width of the formation, and in the permanance of culverts and bridges. The only road of category 1 is from Oro Bay to the Kumusi River. Roads of Category 2 include the major access roads from the main road to the logging area. Roads of category 3 include the road from the major access road to the plantations, and the major feeder road through the plantations. Roads running off the main feeder road are classified as category 4 for the first 1/2 km, and category 5 for the further kilometre.

Table 8.4 shows the estimated road distance by road category from the site of logging in each plantation to Oro Bay. The distance within the plantation is averaged.

Table 8.4 DISTANCE FROM FORESTRY PLANTATIONS TO CHIPMILL AT ORO BAY.

Road	Urarisusu	Hujavasusu	Divinikaiari	Ungona	Korapata	Sui
1	67	67	67	67	72	77
2	8	5	10	5	-	-
3	4	7	4	13	6	6
4	0.4	0.4	0.4	0.4	0.4	0.4
5	0.3	0.3	0.3	0.3	0.3	0.3
Total	79.7	79.7	81.7	85.7	78.7	83.7

It seems from Table 8.4 that the estimated road distances from all the plantations to Oro Bay are very similar. This similarity will permit the calculation of costs to be simplified.

The estimated road construction and road maintenance costs charged to the plantation logging operation are limited because most of the road network will have been constructed for other purposes. The only new road construction that will be required is the link road from the existing road net to the plantations, and the roads within the plantations. The cost of maintenance on the road net outside the plantations will be shared with the Government, part will be charged to the rainforest log-

ging operation of the Logging Company.

Table 8.5 lists the estimates of the lengths of road outside the plantations which are used in transport of wood from the plantations, the distance of road to be constructed, the percentage of maintenance to be born, and the time at which the operation is to begin for each road segment.

Table 8.5 ROAD CONSTRUCTION AND MAINTENANCE ON ROADS OUTSIDE FORESTRY PLANTATIONS TO BE CHARGED TO THE PLANTATION LOGGING OPERATION.

Section	Distance	Construc- tion (km)	Mainte- nance %	Time require (year)
Oro Bay - Hundarituru	67	0	20	13
Korapata-Hundarituru	10	0	20	25
Hundarituru-Hujavasusu	5	0	20	13
Hujavasusu-Serembi	3	0	20	13
Serembi-Urarisusu	3	0	50	13
Hujavasusu-H. plantation	1	1	50	13
Urarisusu-U. plantation	1	1	50	13
Serembi-Divinikaiari	2	0	20	21
Urarisusu-Ungona	9	0	50	21
Divinikaiari-D. plantation	1	1	50	21
Ungona-Un. plantation	1	1	50	21
Warisota-W. plantation	3	0	50	25
Sui - S. plantation	3	0	50	25

Table 8.5 shows that from the commencement of use, the estimated share of maintenance born by the plantation logging operations is 20% on main roads and on roads used by other logging and general traffice, and 50% on roads shared only with general traffic.

Table 8.6 shows the total schedule of road construction and maintenance based on the requirements shown in Table 8.5. In Table 8.6 it is assumed that the feeder road within each plantation is constructed in stages of 0.5 km per year for 10 years and that 50% is to be maintained on average. The lay out of a model plantation is shown in Appendix A. Category 4 and category 5 road is constructed when required for logging. It is not maintained, but is reconstructed each rotation. The length of road to be maintained is in kilometre equivalents. For example a 50% share in road maintenance over 2 km is recorded as 1 km of road maintenance.

Table 8.6 shows that estimated requirements for road construction are limited to road categories 3,4 and 5, and maintenance to road categories 1,2 and 3, and that the total roading required is not very great.

Table 8.6 ROAD CONSTRUCTION AND MAINTENANCE TO BE CHARGED TO THE PLANTATION LOGGING OPERATION BY ROAD CATEGORY (km equivalents).

	Construction category.					Maintenance category				
Year	1	2	3	4	5	1	2	3	4	5
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11			-	-	-					
12			3	2	4	-	-	-		
13			1	2	4	13	3	7		
14			1	2	4	13	3	7		
15			1	2	4	13	3	7		
16			1	2	4	13	3	7		
17			1	2	4	13	3	7		
18			1	2	4	13	3	7		
19			1	2	4	13	3	7		
20			3	4	8	13	3.	7		
21			2	4	8	20	5	14		
22			1	4	8	20	5	14		
23			1	4	8	20	5	14		
24			1	4	8	20	5	14		
25			3	6	12	20	5	14		
26			2	6	12	20	5	24		
27			2	6	12	20	5	24		
28			2	6	12	20	5	24		
29 **			2	6	12	20	5	24		

* Where maintenance is shared the distance is reduced in proportion to the percentage of costs born.

** Beyond year 29 annual roading programme is relatively stable.

Table 8.7 SCHEDULE OF PLANTATION LOG HARVEST.

Year	Area (hectare)	Volume (m3)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12	-	-
13	400	100,000
14	400	100,000
15	448	112,000
16	448	112,000
17	448	112,000
18	484	121,000
19	484	121,000
20	484	121,000
21	740	187,000
22	740	187,000
23	740	187,000
24	740	187,000
25	740	187,000
26	1,188	187,000
27 *	1,452	363,000

* Beyond year 27 plantation log production remain unchanged.

8.4.2 Harvesting and Transport Operations.

8.4.2.1 Inputs and production estimates.

Table 8.7 shows that the estimated schedule of plantation log harvest begins in year 13 at the substantial level of 100,000 m^3, and rises progressively until it reaches a stable level from year 27. From year 26 the plantations are estimated to provide the majority of the chip mill log inputs.

Factors of importance in estimating the number of trucks required for log transport are the distances and road conditions from plantation to mill. The chipwood shown, comes initially from 2 plantations, beyond year 20 from 4 plantations, and beyond year 25 from 6 plantations. The timber from these six plantations travel somewhat different routes to Oro Bay (see Table 8.4; Map No.1(3)). The estimated time of travel for a log truck along each route is shown in Table 8.8.

Table 8.8 TIME OF TRAVEL FOR A LOG TRUCK FROM EACH FORESTRY PLANTATION TO ORO BAY (hours).

Road Category	Urarisusu	Hujavasusu	Divinikaiari	Ungona	Korapata	Sui
1	1.34	1.34	1.34	1.34	1.34	1.34
2 & 3	0.30	0.30	0.28	0.45	0.15	0.15
4 & 5	0.02	0.02	0.02	0.02	0.02	0.02
Total	1.66	1.66	1.64	1.81	1.61	1.71

(3) See Appendix E

The estimated times shown in Table 8.8 were based on the estimated distances shown in Table 8.4 and the estimated road speeds listed in Appendix B. An average distance is used for within plantation travel. The estimated time of travel from plantation to port is very similar. It seems reasonable to adopt an average time of travel for all routes of 1.66 hours. FAO (1974a) maintained that truck speeds on a particular surface tend to be similar whether they are loaded or not. Thus 3.4 hours is adopted as the estimated average round trip time for all log trucks from the Forestry plantations to Oro Bay. The average speed of the trucks is 47 kms per hour and the equivalent average round trip distance is 160 km.

A second factor of great importance in the determination of equipment inputs, and in particular the log trucks required, is the green weight of plantation shortwood. The green weight of E. deglupta shortwood grown under the conditions found in the Saiho area is not known, but an estimate of the green weight may be made by application of the formula given by Bolza *et al.* (1966).

$$\text{Green weight} = \text{Basic density} \times \frac{100 + \text{Moisture content}}{100}$$

Varossieau (1954) stated that the moisture contents of a range of selected North American hardwoods green off the saw were between 38% and 95% for heart wood, and 40% to 92% for sapwood, which suggests an average green moisture contents for sawn of 65%. If 70% is adopted as the green moisture content of E. deglupta chipwood and 557 kg per m^3 (o.d.w.) is adopted as the basic density, the estimate for the green weight using the above equations is 947 kg per m^3. This appears sensible if compared

with a moisture content of 67% and a density of 980 kg per m^3 for Ramin in the green condition (Sarawak Forest Department, 1964). Making allowance for bark and mud on logs, the estimated weight of E. deglupta log is 1,000 kg per m^3.

The harvesting and transport operations may be classified into prelogging survey, shortwood production, snigging and log loading, hauling and unloading. The general factors which apply to these operations are in Appendix B.

The prelogging survey would immediately preceed the logging operation. It would be a simple survey to mark coup boundaries and to locate logging obstacles. The inputs to this operation were estimated to be quite small in proportion to the total operations. The production estimate and the inputs for a survey team are shown in Appendix B.

Shortwood would be produced at the stump. A chainsaw operator and a labourer would clearfell two rows at a time at a slight angle to the line of extraction. Trees would be debranched and bucked to 6 metre lengths where they lie. A production estimate, and equipment and labour inputs per team based on the method of FAO (1974b), is shown in Appendix B.

Snigging of the 3 lines of trees at roadside would be performed first. Then trees would be removed from the rows which run at right angles to the road. Shortwood would be snigged and left buttend to the road. The average snig distance was estimated to be 250 metres approximately (see Appendix A). The inputs and a production estimate for a snigging team are shown in Appendix B, and were based on the method used by FAO (1974 b).

Log transport would be by tray bodied trucks with 2 axle drive. The trucks would be equiped with an hydraulic loader, which enables the truck to load direct from the roadside stacks. Estimate production is shown in Appendix B. Truck driver/operators would work 4 x 10 hours shifts per week, with 8 hours of actual operations per shift. The estimated production which was based on the method used by FAO (1974 a), may be found in Appendix B.

The estimated hours of operation of each category of equipment required for harvesting and transport operations is shown in Appendix B. The numbers of machine years per annum for each item of equipment are shown in Table 8.9.

Table 8.9 shows there would not be a 1:1 ratio between the teams engaged in the extraction process, thus a considerable degree of coordination would be required. Allowance is made in the estimates for one foreman for every 15 men engaged on extraction and logging. This was the ratio used by FAO (1966).

Table 8.9 INPUTS OF HARVESTING AND TRANSPORT EQUIPMENT*.

(machine years per annum).

Operation :	Survey operation	Chipwood production	Snig	Load/transport/unload
Equipment**: Year	Utility	Chainsaw	Tractor	Truck/loader
13	0.08	14.0	19.3	17.0
14	0.08	14.0	19.3	17.0
15	0.09	15.7	21.7	19.0
16	0.09	15.7	21.7	19.0
17	0.09	15.7	21.7	19.0
18	0.10	16.9	23.4	20.6
19	0.10	16.9	23.4	20.6
20	0.10	16.9	23.4	20.6
21	0.15	25.9	35.8	31.5
22	0.15	25.9	35.8	31.5
23	0.15	25.9	35.8	31.5
24	0.15	25.9	35.8	31.5
25	0.15	25.9	35.8	31.5
26	0.24	41.6	57.4	50.5
27	0.29	50.8	70.2	61.7
28	0.29	50.8	70.2	61.7
29	0.29	50.8	70.2	61.7
30	0.29	50.8	70.2	61.7

* Road machinery excluded.

** Hours operated per year for each machine may be found in Appendix

Table 8.10 LABOUR REQUIRED FOR HARVESTING AND TRANSPORT (man days)

Year	Supervisors		Operator/Driver		Chainsaw Operator	Labour		
	Logging	Survey	Snigging	Load/haul		Survey	Shortwood Production	Skidding
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12	-	-	-	-	-	-	-	-
13	1,250	20	4,000	6,000	3,500	40	3,500	8,000
14	1,250	20	4,000	6,000	3,500	40	3,500	8,000
15	1,500	22	4,480	6,720	3,920	45	3,920	8,960
16	1,500	22	4,480	6,720	3,920	45	3,920	8,960
17	1,500	22	4,480	6,720	3,920	45	3,920	8,960
18	1,500	24	4,840	7,260	4,235	48	4,235	9,680
19	1,500	24	4,840	7,260	4,235	48	4,235	9,680
20	1,500	24	4,840	7,260	4,235	48	4,235	9,680
21	2,500	37	7,400	11,100	6,475	74	6,475	14,800
22	2,500	37	7,400	11,100	6,475	74	6,475	14,800
23	2,500	37	7,400	11,100	6,475	74	6,475	14,800
24	2,500	37	7,400	11,100	6,475	74	6,475	14,800
25	2,500	37	7,400	11,100	6,475	74	6,475	14,800
26	4,000	59	11,880	17,820	10,395	119	10,395	23,760
27 •	5,000	73	14,520	21,780	12,705	145	12,705	29,040

• Beyond year 27 annual inputs remain unchanged.

The estimate of labour required for harvesting and transport is shown by employment categories in Table 8.10. In year 13 more than half the estimated manpower is skilled labour and this would come from outside the area. The estimate of a total of 11,540 man days or the equivalent of 48 man years of unskilled labour required in year 13. An estimated of 95,968 man days, or 400 man years of labour is required by year 27 and in subsequent years. By that time most of the work force will be in the modern sector, and this labour demand should be easily satisfied.

Other inputs including staff and overheads are not itemized directly. This group of inputs would normally include management and technical staff, offices, stores, workshops, forest camps, equipment and supplies. The estimated cost of these items is allowed as a percentage loading on direct harvesting and transport costs.

8.4.2.2. Costs of harvesting and transport operations.

Table 8.11 shows the estimated cost of operating various items of equipment.

Table 8.11 DELIVERED COST AND OWNING AND OPERATING COST OF VEHICLES AND MACHINERY USED DIRECTLY IN PLANTATION HARVESTING AND LOG TRANSPORT.

	Delivered Cost Northern District P.N.G. (Kina)	Owning & Operating Cost (Kina per hour)
Utility	2,718	1.84
Chainsaw	500	2.03
Snig Tractor	12,925	3.14
Log truck	26,017	15,51
Hydraulic/Loader	8,000	13,16

The estimates of delivered cost shown in Table 8.11 were based on Australian market prices suitably adjusted (see Appendix B). The owning and operating costs were estimated by using the approach of De Vriers (1973).

Estimates of wage rates for employees directly engaged in operations are shown in Table 8.12

Table 8.12 WAGE RATES BY CATEGORY OF WORKER (Kina).

Foreman logging	3,250
Level 1 Supervizor	1,950
Labourer	650
Driver/operator	2,600
Chainsaw operator	1,300

Source : Based on White (1975).

Table 8.12 shows the present large difference in wage levels of skilled and unskilled categories.

Road construction and maintenance costs were based on the schedule shown in Table 8.6 and the unit costs shown in Table 8.13.

Table 8.13 COSTS OF ROAD CONSTRUCTION AND MAINTENANCE *
(Kina per kilometre).

	Road Category				
	1	2	3	4	5
Construction	10,000	7,000	4,400	1,880	400
Maintenance	300	220	168	-	-

* Allowance for cost of culverts and bridges is included.

Source : Based on FAO (1974a).

The estimated costs per kilometre shown in Table 8.13 include an allowance for one concrete bridge with a 10m span every 5 km at a cost of K4,000 for roads of category 2, and for 2 concrete culverts every 1 km at K10 per metre for roads of category 2 and 3. It is assumed log structures are used for roads of category 4 and 5. These provisions should be adequate to cover the cost of bridges for the few deep gullies and other drainage lines which occur in the area. Maintenance was estimated to be K100 plus 2% of construction costs per km.

The estimated overheads and other costs were difficult to itemize and thus the estimate is based on a percentage of the direct logging costs. The percentage used (23%) was determined

by reference to two logging models, fully costed by FAO (1966), the main characteristics of which are shown in Appendix B. A ratio was established between overhead costs and direct logging costs for these two models, and this was converted to a percentage which was found to be 21% in both cases. To justify this approach it was necessary to remove the direct cost of supervision and the interest charges before calculation of the percentage overheads. These were calculated directly. The figure of 21% was adjusted upwards to 23% to ensure an adequate provision to cover these costs. It should be noted that the FAO models are for more extensive logging operations, which suggests total direct costs should be relatively higher in the case of plantations. On the other hand, a comparison of the percentage overheads of the two models suggests stocking of the area logged makes little difference to overhead costs. Moreover the FAO models made provision for full camp facilities. Few camps would be required for the plantation logging operation. This suggests the provision for overheads should be reduced. On balance 23% appears to be a reasonable figure.

Estimates of total costs of the plantation logging and transport operations are shown in Table 8.14.

Table 8.14 COSTS OF PLANTATION LOGGING AND TRANSPORT OPERATIONS*

Year	Road construction & maintenance	Survey logging & transport		Overheads*	Contengencies**
		Equipment	Wages		
12	18,560	-	-	-	1,856
13	15,496	713,340	165,412	202,113	109,636
14	15,496	713,340	165,412	202,113	109,636
15	15,496	798,941	186,198	226,582	122,721
16	15,496	798,941	186,198	226,582	122,721
17	15,496	798,941	186,198	226,582	122,721
18	15,496	863,143	200,016	244,527	132,318
19	15,496	863,143	200,016	244,527	132,318
20	29,656	863,143	200,016	244,527	133,734
21	28,927	1,319,680	307,962	374,357	203,097
22	24,572	1,319,680	307,962	373,357	202,657
23	24,572	1,319,680	307,962	374,357	202,657
24	24,572	1,319,680	307,962	374,357	202,657
25	38,732	1,319,680	307,962	374,357	204,073
26	36,012	2,118,622	494,270	600,965	324,986
27	36,012	2,589,244	605,493	734,790	396,553
28	36,012	2,589,244	605,493	734,790	396,553
29	36,012	2,589,244	605,493	734,790	396,553
30	36,012	2,589,244	605,493	734,790	396,533

* A return to capital is not included in these costs.

** Allowance for contingencies is 10% of other costs and includes overheads on labour costs.

It seems from Table 8.14 that the estimated costs are very largely equipment costs. These in turn are very largely transport costs (see Appendix B). Estimated direct wages are of considerable importance. The bulk of these is wages for skilled labour. Estimated roading costs are small. The provision for contingencies is 5% of the total of direct costs and overheads.

8.4.3 Balance Sheet for the Plantation Logging and Transport Operations.

A simplified balance sheet is shown in Table 8.15. The estimated outgoings include the direct costs, overhead and other costs, and contingencies from Table 8.11; a provision for profit to cover return to capital, risk, and entrepreneurial skill, a provision for company tax, and a provision for stumpage. Receipts are from sales of chipwood.

The receipts from sales were based on a price of K14.52 per m^3 (see Section 8.3) and the logging schedule in Table 8.7. The provision for profit is 10% of the average tied up capital (see Appendix B)(4). The provision for tax is estimated to be 25% of before tax profit. Company tax is believed to be approximately 25%. The provision for stumpage is the difference between receipts and the total of all other outgoings. The provision for stumpage is regarded as a best estimate of the cash the company would be prepared to pay for the chipwood it harvested (see Table 8.7).

It seems from the estimates in Table 8.15 that total outgoings are largely direct costs, and from Table 8.14 that these are largely machinery and vehicle costs. From Appendix B it seems

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(4) This is after tax. See also discussion P163.

Table 8.15 BALANCE SHEET FOR THE PLANTATION LOGGING AND TRANSPORT OPERATION (Kina).

Year	Outgoing				Receipts
	Direct costs Overhead & other costs & Contengencies	Stumpage	Industrial Tax	Profit	
11	-	-	-	-	-
12	20,416	(-)22,967	510	2,041	-
13	1,205,997	232,486	20,710	82,807	1,542,000
14	1,205,997	232,486	20,710	82,807	1,542,000
15	1,349,932	263,218	22,778	91,112	1,727,040
16	1,349,932	261,833	23,055	92,220	1,727,040
17	1,338,931	272,834	23,055	92,220	1,727,040
18	1,455,500	286,295	24,805	99,220	1,865,820
19	1,455,500	286,295	24,805	99,220	1,865,820
20	1,471,076	265,995	25,750	102,999	1,865,820
21	2,234,068	426,989	38,329	153,314	2,852,700
22	2,229,228	432,589	38,177	152,706	2,852,700
23	2,229,228	432,589	38,177	152,706	2,852,700
24	2,229,228	432,589	38,177	152,706	2,852,700
25	2,224,804	412,067	38,966	155,863	2,852,700
26	3,574,855	700,788	60,819	234,278	4,579,740
27	4,362,092	866,373	73,799	295,196	5,597,460
28	4,362,092	866,473	73,799	295,196	5,597,560
29	4.362,092	866,473	73,799	295,196	5,597,460
30	4.362,092	866,473	73,799	295,196	5,597,460

* 25% of Company surplus

** The stumpage item is calculated to balance the sheet and hence is negative in year 12.

these in turn are largely transport costs. Stumpage is also an important cost to the logging company. The provision for profit and tax are small by comparison.

CHAPTER 9

FINANCIAL ANALYSIS OF THE PLANTATION PROJECT.

9.1 INTRODUCTION.

9.1.1 Distinction Between Financial and Social Analyses.

The objective of both these forms of analysis is to estimate the present worth of the project. In both cases benefits and costs are identified and estimated before discounting and summing to obtain an estimate of the present worth.

The two types of analysis are distinguished by the viewpoint taken and the range of consequences considered. In a financial analysis the viewpoint taken is that of the entrepreneur. Only financial costs and benefits are considered. Thus costs are based on inputs valued at market prices and include taxes. Benefits are based on outputs valued at market prices and include subsidies. The rate of discount appropriate to a private enterprize is used to discount the benefits and costs to one point in time.

The viewpoint taken in a social analysis is that of Papua New Guinea society as a whole. In this case the social costs and benefits considered include those incurred by society as a result of the project and will thus include externalities. In this essay benefits and costs will be valued in consumption equivalents. Market values are used where they provide a reasonable estimate

of social values, but more complex methods of valuation are used where the market is clearly imperfect. Taxes and subsidies are regarded as transfers rather than costs or benefits to society and do not appear in the analysis. A social rate of discount is used to obtain the present worth of the project.

9.1.2 Outline of the Financial Analysis.

In financial analysis a common practice is to estimate the money available to recover capital invested in the project, and to compensate for the use of that money. The stream of annual amounts available is termed the cash flow (Gittinger, 1972). Borrowed funds are generally treated as a benefit, and the principal and interest repayments as costs. The way project worth is estimated depends on the circumstances.

In the case of the plantation project the objective of the analysis is to determine the financial viability of the project from the viewpoint of a private entrepreneur. The estimate of the present worth of the project is based on present worth in year 3 (year 1 of the plantation project). Use of the present worth avoids the problems associated with the cost benefit ratio, and the internal rate of return (Gittinger, 1972). The project is assumed to continue to infinity to avoid the problem of valuation of the assets at termination. The discount rate for capital in the private market (i.e. The marginal rate of return before tax) is used to discount the annual balances to year 3. For simplicity it is assumed that all funds are provided by one prospective "company" containing various subclans who own the land at present.

Plantation revenues were estimated in Chapter 8. Stumpage price was estimated as the residual cash flow from the logging operation after provision was made for normal profit and tax by the logging company (see Chapter 8).

9.2 COSTS OF ESTABLISHMENT AND MAINTENANCE.

9.2.1 Costs of Staff and Labour.

Table 9.1 lists the salaries of various categories of employee. These are based on estimates of White (1975). The outstanding feature of this table in the relatively very high salaries of expatriates.

Table 9.1 SALARY AND WAGE STRUCTURE.

Category	Annual Salary (Kina per annum)
O.I.C. (Expatriate)	20,800
O.I.C. (Indigene)	10,400
Accountant (Indigene)	10,400
Paycler*	3,250
Typist	1,430
Medical Assistant	1,950
Carpenter	2,600
Carpenter Assistant	1,560
Driver	1,950
Level 3 supervizor (Expatriate)	15,600
L3 (Indigene)	7,800
L2 (Expatriate)	10,400
L2 (Indigene)	5,200
L1 (Indigene)	1,950
Labourer	650

* Estimated level December 1976.

The estimates shown in Table 9.1 are based on White (1975). Estimates for expatriates salaries are very high in comparison with those of indigenes and skilled indigenes are highly paid in relation to unskilled labourers. The estimated labour rate does not include an allowance for sick pay or holiday pay. These were included in the contingencies provision. FAO (1974a) suggested that indirect costs associated with labour may range from 20% to 100% of direct wage costs. In this case local village labour will be used. Housing will not be required for labour, and transport of labour is minimal. Thus the indirect costs of labour were taken to be 10% of direct wage costs.

9.2.2 Costs of Machinery and Vehicle.

Table 9.2 shows the estimated cost per hour to operate various vehicles and equipment.

Table 9.2 OPERATING COST OF VEHICLE AND MACHINERY (K per hour).

Station Sedan	3.26
Utility	1.84
Motor Cycle	0.72
Water tanker	35.79
Plough	1.07
Agriculture tractor	2.26
Plant carrier	0.62
Crawler tractor *	22.82
Grader **	14.31

** The rate shown is the estimated hire rate.

The rates shown in Table 9.2 are based on detailed estimates of owning and operating costs in Appendix B and Appendix C. The basis of the hire rates for tractors and graders is shown in Appendix C. Some specifications of the equipment are shown in Appendix A. The estimates of delivered prices on which the owning and operation costs were based are shown in Appendix B and Appendix C.

Table 9.3 shows that the estimated hourly hire rate for a crawler tractor is high. The hourly rates for grader and water tanker are also high. There is a very substantial difference in running costs between station sedans, utilities and motor cycle.

9.2.3 Other Plantation Costs.

Buildings, office furniture and equipment, and communication equipment were treated as capital items. The estimates for buildings were calculated seperately. The estimates for office furniture and equipment and communication equipment were calculated in a lump sum. These estimates are also shown in Appendix C. The estimates were based on those of White (1975), some adjustment being made for the different planting rates.

The estimated cost of supplies were also based on estimates of White (1975), appropriate adjustment being made for scale. Where White (1975) did not provide an estimate, the basis used is shown with the estimate (see Appendix C). The estimates for petrol, oil, and lubricants, were based on the estimated hourly rate of consumption of each category of vehicle or machine, these are shown in Appendix C.

9.2.4 Total Costs.

Table 9.3 shows the estimated total costs of establishing and protecting the plantations.

It seems from Table 9.3 that staff salaries are a very important cost. In early years 45% of total costs are attributed to staff salaries. Most of the estimates for salaries are attributable to the 3 expatriates who receive K45,800 out of total costs of K168,000 in year 4. Salaries remain an important cost although their relative importance declines with time. By comparison the estimates for the cost of labour is less important in the early years, but the estimates increase with the planting rate to be approximately 30% of the total costs at the time planting or rainforest sites reaches a peak. In later year estimates for the cost of labour decline but they continue to be important.

Estimates of the total costs of machinery and vehicles roughly parallel those for labour. The estimates for machinery and vehicles costs are largely attributable to tractor hire for the clearing of rainforest sites (see Table 7.6; Table 9.2; Table 7.5). Although the hourly rate for some other items of equipment is high (see Table 9.2), these items are operated for relatively short periods (see Appendix B, Appendix C). The high hourly rate is largely attributable to depreciation (see Appendix C). Operations other than clearing require much less machinery time (see Table 7.6; 7.5). The estimates of the costs for transport form part of the estimated vehicle and equipment owning and operating costs and are not very important. A useful but not large reduction in the estimates would result if utilities or even motorcycles were substituted for land cruisers.

Table 9.3 COSTS OF THE PLANTATION PROJECT (Kina).

Year	Staff	Labour	Buildings (1)	Vehicle & Equipment Own & Operate	Plant Hire (1)(2)(3)
11					
2	-	-	-	-	-
3	64,480	10,036	18,416	7,060	12,443
4	80,080	16,276	20,378	7,060	12,548
5	71,630	17,238	19,540	9,883	14,123
6	71,630	17,989	19,540	9,883	14,237
7	71,630	17,989	19,540	9,883	14,328
8	79,430	19,295	21,502	9,883	15,538
9	63,830	19,856	19,540	9,883	15,681
10	63,830	19,856	19,540	9,883	15,805
11	67,340	34,216	22,575	13,895	34,640
12	67,340	43,571	22,575	13,895	34,827
13	56,940	43,571	22,886	13,895	37,177
14	56,940	42,635	22,886	13,895	41,007
15	56,940	42,635	22,886	13,895	41,076
16	81,770	67,930	25,244	14,527	74,712
17	81,770	99,005	25,244	14,527	98,182
18	81,770	108,615	25,582	14,527	94,387
19	81,770	107,970	25,582	14,527	95,117
20	81,770	108,532	25,582	14,527	95,346
21	81,770	108,532	25,582	14,527	95,505
22	81,770	99,679	25,582	14,527	88,705
23	81,770	94,354	25,582	14,527	88,879
24	81,770	94,354	25,582	14,527	89,038
25	81,770	94,354	25,582	14,527	89,212
26	81,770	94,354	25,582	14,527	89,326
27	81,770	77,342	25,582	14,527	75,987
28	81,770	59,501	25,582	14,527	69,998
29*	81,770	54,925	25,582	14,527	69,998

(1) Includes : Depreciation, Insurance, Maintenance.

(2) Includes : petrol, oil and lubricants.

(3) Includes : operator and margin for profit to logging company.

* Beyond year 29 annual cost remain the same.

Table 9.3 (cont.)

Office Furniture & Equip. (4)	Communication Equipment (2)	Supplies (5)	Interest	Contingencies	Total costs
-	-	-	-	-	-
100	-	7,490	8,558	12,858	141,441
100	-	7,490	9,273	15,321	168,526
100	730	5,000	9,737	14,789	162,779
360	1,400	7,380	10,997	15,315	168,471
360	1,400	7,587	10,997	15,325	168,572
360	1,400	7,587	11,712	16,645	183,092
360	1,400	7,587	10,997	14,887	163,761
360	1,400	7,587	10,997	14,898	163,898
360	1,400	11,687	12,605	19,746	217,204
360	1,400	11,687	12,605	20,810	228,905
360	1,495	11,687	12,833	20,047	220,514
360	1,675	10,487	12,833	20,247	222,718
360	1,675	10,487	12,833	20,254	222,794
600	1,675	14,136	13,875	29,397	323,364
600	1,675	11,348	13,875	34,172	375,896
600	1,760	16,776	14,103	35,759	393,349
600	1,760	16,726	14,103	35,763	393,388
600	1,760	16,726	14,103	35,842	394,258
600	2,050	16,726	14,103	35,900	394,895
600	2,050	16,726	14,103	34,344	377,676
600	2,050	16,726	14,103	33,819	372,010
600	2,050	16,726	14,103	33,835	372,185
600	2,050	16,726	14,103	33,852	372,376
600	2,050	16,726	14,103	33,864	372,502
600	2,050	16,453	14,103	30,800	338,796
600	2,050	16,343	14,103	28,407	314,481
600	2,050	14,849	14,103	27,800	305,804

(4) includes depreciation and maintenance,

(5) includes office, nursery and plantation supplies, and petrol and lubricants for vehicles owned and operated.

The most important of the remaining estimates is for buildings. Contingencies do become more important in later years. The estimates for interest were 10% of the sum total of the estimated average value over its life, of each capital item in use in the particular year. Further details of these items are shown in Appendix C.

9.3 BALANCE SHEET OF THE PLANTATION PROJECT.

The estimates of the outgoings are the total of all costs each year (see Table 9.3). The estimates of the receipts are the stumpage provision of the logging company each year. (see Table 8.15). The balance of these items is shown in Table 9.4.

It seems from the estimates in Table 9.4 that the project does not earn a substantial surplus until year 26, and the deficit balances are substantial for a least 14 of the preceeding years. However there is a considerable surplus each year beyond year 26.

An estimate for the networth in year 3 was obtained in 2 steps. Beyond year 29 the annual balance remains constant. It was convenient to first capitalize this stream to year 29. The networth of the project in year 3 was then obtained by summation of the net worth in year 3 of each annual balance to year 28, and the net worth in year 3 of the stream capitalized to year 29. This yields a net worth in year 3 of :

K(-)619,248

Calculations are shown in Appendix C.

Table 9.4 BALANCE SHEET OF THE PLANTATION LOGGING OPERATION.

Year	Outgoing	Returns from Stumpage	Balance	
			Positive	Negative
1				
2	-			-
3	141,441			141,441
4	168,526			168,526
5	162,779			162,779
6	168,471			168,471
7	168,572			168,572
8	183,092			183,092
9	163,761			163,761
10	163,898			163,898
11	217,204			217,204
12	228,905	22,967		251,872
13	220,514	232,486	11,972	
14	222,718	232,486	9,768	
15	222,794	263,218	40,424	-
16	323,364	261,833	-	61,531
17	375,896	272,834	-	103,062
18	393,349	286,295	-	107,054
19	393,388	286,295	-	107,093
20	394,258	265,995	-	128,263
21	394.895	426,989	32,094	
22	377,676	432,589	54,193	
23	372,010	432,589	60,579	
24	373,185	432,589	59,404	
25	372,376	413,067	40,691	
26	372,502	700,788	328,286	
27	338,796	866,373	521,577	
28	312,481	866,373	553,892	
29**	305,804	866,373	560,569	

* The negative value arises because the estimate of the receipts is based on the provision for stumpage by the logging comapny .

** The annual values remain constant beyond year 29.

9.4 FINANCIAL VIABILITY OF THE PLANTATION PROJECT.

9.4.1 Present Net Worth and Financial Viability.

The financial analysis is a projection of past experience into the future and being deterministic it does not account the many uncertainties and risks inherent in long term projects of a biological nature. The methods of establishment and protection are likely to change. For example it may not be necessary to rip sites before replanting. Moreover experience may show that actual costs differ from the cost estimates. This is most likely to be the case with production estimates, expecially machine clearing and labour tending. Uncertainty associated with early operations which bear heavy interest charges could make a considerable difference to costs. In addition there are some risks associated with the plantation project which are not accounted in the analysis. Of these the most important is that of fire. Fire outbreaks in the grassland areas during the dry part of the year are likely and must pose a threat to any plantation established. There is also some possibility that disease will prove to be a problem as E. deglupta has not been grown previously in this particular area. In addition it is possible there may be social unrest even though great care was taken in planning to reduce the likelyhood of friction among the local people.

Revenues depend largely on the growth rate and stumpage rate of E. deglupta. This species has been tried in very similar locations elsewhere in Papua New Guinea and a reasonable degree of confidence can be attached to the estimated growth rate although

some uncertainty must remain.

Far greater uncertainty is attached to the established stumpage price. It was not possible to obtain data on the large number of factors which contribute to the process of price formation of E. deglupta at the stump, nor to forcast changes in these factors over time. The estimated stumpage price was based on an estimate of the mill door value of mixed tropical hardwood chips at Madang in the early 1970's which is not very satisfactory. It was shown in Chapter 8 that stumpage estimate based on the recent work of Phillips et al. (1977) would be substantially lower. Although likely to be more reliable this estimate would also be based on a number of assumptions relating to shipping costs and to relative price movements over time. In the absence of a satisfactory estimate for stumpage the results of the financial analyses must be treated with reservations.

The present net worth obtained also depends to a large extent on the method of analysis. The discount rate was estimated to be 10%. The rate itself appears sensible for funds provided by a private company (see Chapter 10). It may be possible to borrow a substantial proportion of the funds required at semi-commercial interest rate (see Chapter 10) and were this the case the present net worth of the project would become more favourable. No provision was made in the analyses for land rent or for the payment of company tax but inclusion of realistic costs to cover these would reduce the present net worth by a relatively small amount. These would only become substantial costs well into the future. The practice of using December 1976 prices seems sensible. The price

of chipwood and the costs of various categories of inputs would be affected by inflation to different extents, however these changes may approximately balance out in practice.

9.4.2 Important Determinants of Profitability.

Such determinants are suggested by the financial analysis. The net worth of K(-)619,248 is equivalent to an annual deficit of K61,925 where the interest rate is 10%. This is equivalent to approximately 35% of total plantation costs in the early years. It seems most unlikely the project could be made financially viable by changing management procedures alone. However under certain circumstances annual stumpage might increase by an equivalent amount.

The stumpage received was estimated to be the stream of residual annual balances of the logging company. An increase in these payments of K160,828 each year from year 13 would make the plantation project financially viable. This would be possible if the logging company were to save or to obtain extra revenue for an equivalent amount.

The largest costs of the logging company are those for transport (see Table 8.14). A sum of K161,000 could be saved if transport costs were reduced 33% approximately. It is estimated that were the plantations located only 50 km from Oro Bay on a similar site the required savings could be made. A truck could make 3 round trips per day over this distance compared to 2 at present (see Appendix B) which would result in a reduction in transport costs of roughly 33%. If the green weight of E. deglupta short wood proved to have a basic density of 670 kg per m3 or 33%

less than the estimated value the same saving would be made.

An equivalent saving would be made if the mill door price of chipwood were to rise 10% in real terms from K14.52 per m^3 to K16.00 per m^3. This is equivalent to an estimated 4% rise in the f.o.b. price N. coast Papua New Guinea, or an estimated 2% rise in the c.i.f. price Japan ports. A price rise of this amount at any time within the next 13 years seems likely to be sufficient to make the plantation project financially viable.

It seems that financial viability of the plantation would largely depend on changes beyond the control of the Forest management. Although this may be the case the analysis provide some insight into ways in which the management might influence profitability. For example it seems that the selection of site type has a major impact on the plantation establishment cost.

Table 9.4 LABOUR AND MACHINERY COSTS OF PLANTATION ESTABLISHMENT BY SITE TYPE. (Kina per hectare).

	Grassland	Clear Rainforest	Clearfelled Plantation
Labour	34.6	87.6	32.2
Machinery	15.6	73.0	30.6

The costs in Table 9.4 include most of the direct costs (see Table 7.2b; Table 7.5; Appendix C). The estimated direct costs of plantation establishment on grassland are only 1/3rd those on cleared rainforest. If all forests were established

on grassland site it seems the savings could be considerable. For example in year 20 a sum of K105,984 would be saved. Savings could also be made by continuing to plant grassland in preference to replanting. This would have the added advantage of making former grassland available in a form suitable for cultivation.

Financial viability could also be influenced by varying the relative proportion of inputs of men and machines or by delaying the start of the project. The latter possibility would far eliminate the need for expatriate staff and large savings of salaries would be made.

It is clear from the analysis that the plantation project is not financially viable in its present form and location. Moreover financial viability could not be achieved simply by modification of form of the project. A plantation company would require a stumpage greater than that estimated to be available.

CHAPTER 10

SOCIAL PRICES OF PLANTATION INPUTS.

10.1 OUTLINE.

Estimation of the social price of the various plantation project inputs is a necessary first step in social analysis. In this chapter the social value of labour, imports, locally produced goods, and capital, is considered in terms of consumption. Where the markets are clearly imperfect shadow prices have been calculated.

10.2 LABOUR.

Labour may be conveniently classified as unskilled, skilled indigenous, and expatriate labour.

10.2.1 Unskilled Labour.

In the Northern District most people in rural area obtain a living from subsistance agriculture but there is large scale unemployment. The wage rate and opportunity cost of labour would lie far below the productivity of labour if labour were dependant on the modern sector and there was a free market. However most indigenes can do without work in the modern sector and the wage rate relates to the marginal opportunity cost of recreation and leisure. Hence the opportunity cost of labour was estimated from the marginal rate of productivity of the average worker adjusted downwards to allow for the proportion of the work force engaged in pro-

duction in the modern sector. The shadow price of labour is the ratio of the marginal productivity, suitably adjusted, and the wage rate.

Moulik (1973) calculated the average productivity of indigenes engaged in cash cropping in the Milne Bay District to be $0.28 per hour. This is equivalent to K3.66 per 8 hour day at December 1976 prices. There are many similarities between the Milne Bay area as it existed in 1973 and the Northern District in 1976. The culture and level of development were similar. Moreover cash croppers in both areas were subject to the international market, and both local markets appeared to be free of distortion. Furthermore world prices in 1972-73 were about average. (P.N.G. Bureau of Statistics, 1974). Thus K3.66 per man day seems to be a fair estimate of the average productivity of the average cash crop worker in the Northern District in December 1976. It is also a reasonable estimate of the marginal productivity of the average worker.

The work force of the Northern District may be divided into youths, adults who engage in cash cropping, and adults who do not. The proportionate contributions at the margin of these groups to plantation labour, and the sources of the opportunity forgone are summarized in Table 10.1.

Table 10.1 PROPORTIONATE CONTRIBUTION AT THE MARGIN TO PLANTATION LABOUR AND THE SOURCES OF OPPORTUNITY COSTS.

Age group	Proportionate Contribution at Margin to Plantation Labour.	Source of Opportunity Forgone.
Youth	0.5	recreation & leisure
Adult	0.333	"
Adult	0.166	cash cropping

It seems from Table 3.4 that village youth form approximately 50% of the working age population and they are estimated to form 50% of the potential workforce although at present they seldom engage in cash cropping. Use of their labour generally involves a loss of leisure, or council or church work. These are their least valued activities (see Chapter 6). Thus use of their labour would involve very little opportunity cost to production or consumption. The same argument applies to adults who do not engage in cash cropping.

It is estimated that in rural areas of the Northern District 2 in 3 adults engage in cash cropping. Data collected by Crocombe et al (1963) suggests the ratio was 1 in 10 of the work force at Inonda in 1963. Table 3.2 and Table 3.4 shows the ratio had risen to 1 in 4 by 1971 .. It is estimated to have reached 1:3 by 1976. As 50% of the workforce are youths who seldom engage in cash cropping,the ratio of adults who engage in cash cropping is calculated to be 2 in 3. Were these adults who engage in cash cropping to be employed on the project there would be an opportunity cost to cash

crop production. This cost would be limited because the project is designed to limit labour demand from any particular area, and because the individual can choose when his labour is committed to both activities. Time lost from cash cropping by this group is estimated to be 50%. The marginal productivity of the average adult who engages in cash cropping is :

0.5 x 0.66 x 3.66 Kina per day.

and the marginal productivity of the average member of the workforce

0.5 x 0.5 x 0.66 x 3.66 or 0.60 Kina per day.

The shadow price of labour in year 1 is thus

0.60/2.60 or 0.23 Kina per Kina.

The situation seems likely to remain essentially the same in year 10. However marginal productivity would rise and is estimated to be x1.2 that in year 1. It is estimated the proportion engaged in cash cropping would have risen to 0.9. It is estimated the proportion of days spent by these indigenes on cash crops would have risen to 0.5. Hence it is estimated employment of the average worker would involve an opportunity cost of

0.9 x 0.5 (1.2 x 3.66) or 1.98 Kina per man day

and it is estimated the shadow price of unskilled labour would be

$$\frac{1.98}{2.60} \quad \text{or} \quad 0.76 \text{ Kina per Kina.}$$

By year 30 it seems likely the situation would be entirely different. Most workers would be dependant on the modern economy.

Subsistance agriculture would be relatively unimportant. It is estimated that the opportunity cost of labour (and the wage rate) would be 0.7 of the marginal productivity of labour. The opportunity cost of labour would be :

0.7 (2 x 3.66) or 5.12 Kina per man day.

and the shadow price of labour is estimated to be ;

$$\frac{5.12}{2.6} \quad \text{or} \quad 1.97 \text{ Kina per Kina.}$$

In year 30 it seems likely some unemployment will remain. During the intervening years the demand for labour would be rising because of a rise in economic activity and in labour productivity. Labour productivity in year 30 is estimated to be X2 that in year 1. This rise in demand is likely however to be more than offset by the increase in supply resulting from an increase in population and by increasing substitution of labour.

10.2.2 Indigenous Skilled Labour.

Skilled workers form part of the labour market of the modern economy. Because supply is short few remain unemployed. Thus the marginal wage rate should approximate the marginal productivity of labour and the opportunity cost of labour. However the wage rates are fixed at such a level that employers frequently choose to employ expatriates at higher wages. This suggests the marginal productivity of labour and the opportunity cost of labour are slightly below the regulation wages. It is estimated that the marginal productivity and opportunity cost of skilled labour is 0.9 W Kina per man day and the shadow price of skilled labour is

$$\frac{0.9\ W}{W} \quad \text{or} \quad 0.9 \text{ Kina per Kina.}$$

Where W is the wage rate for the particular category of worker.

Over 30 years it is estimated the marginal productivity of skilled labour would rise to x1.5 that in year 1. That is to (0.9 x 1.5)W Kina per man day. Demand would rise with the increase in economic activity. However supply would rise faster than demand as more and more indigenes receive training. Hence there would be some unemployment and the opportunity cost and possibly the wage rate would lie below the marginal productivity of skilled labour. It is estimated the opportunity cost of skilled labour would be 0.8 the marginal productivity of skilled labour, that is :

$$0.8 \times (0.9 \times 1.5)W \quad \text{or } W(1.08) \text{ Kina per man day}$$

and it is estimated that the shadow price of skilled labour would be

$$\frac{1.08\ W}{W} \quad \text{or} \quad 1.08 \text{ Kina per Kina.}$$

10.2.3 Expatriate Labour.

Expatriates in Papua New Guinea receive a salary comparable to that in other countries with efficient labour markets and relatively full employment. Hence the salary paid is a fair estimate of the value of their marginal productivity. In Papua New Guinea to day, expatriate professionals are in short supply. Therefore their opportunity cost and wage are estimated to be similar to their marginal productivity. The shadow price of expatriate labour is estimated to be 1.

10.2.4 The Rate of Increase in the Real Wage.

It is estimated that between year 1 and year 30 the wage rate of unskilled labour would tend towards the opportunity cost of labour and the real wage rate would rise from K2.60 per man days in year 1 to K5.12 per man day in year 30. That is an average rate of increase in the real wage of unskilled workers of 2%. For skilled workers it is estimated the real wage rate would rise from between K18 and K43 per man day depending on the category of skill to between K19.5 and K46.5 per man day. The implied rate of the real wage of skilled workers of less than 1%. Both rates seem not unreasonable given that present wage rates are rather high in comparison with most other under developed countries.

Intermediate values of the shadow prices of labour are based on linear interporlation between the estimates obtained for particular years for the particular category of labour.

10.3 IMPORTS.

In a national economy which is in general free of import restriction, a shift in the price of a good on the world market would be followed by an appropriate change in the price of the good on the local market. The balance of trade would be maintained by automatic adjustment within the economy. In most economies however the local price of some goods is not responsive to price changes of that good on the world market. For example the wage rate is frequently determined in the short term, by political factors in the local environment. If local wages do not fall with

a fall in the wage rates of trading partners, then labour purchasing power and imports are maintained, while at the same time exports begin to fall. The result is a growing trade deficit.

A nation in this position may restore the balance of trade in a number of ways. It may adjust the exchange rate downwards to reduce the value of the home wage in real terms. This effectively reduces the demand for imports. Or it may apply special measures such as tariffs and quotas to reduce imports. If the latter course is followed the currency would be overvalued. There would be a rundown in foreign exchange reserve, and this may force the Government to apply exchange controls. A situation where the currency is overvalued is thus usually characterized by stable exchange rates accompanied by substantial levels of tariffs, quotas, and exchange controls. In such circumstances the price of both imports and exports is below their accounting price or their real value to the nation, and it is necessary in any social analyses to shadow price imports or exports used in or produced by the nation.

The maintenance of a "hard" currency is a central plank of policy of the Papua New Guinea Government (see Chapter 3) and there is good evidence this policy is pursued in practice. At the time of floating the new currency, the Kina, in April 1976, prices for agricultural exports of coffee and cocoa were strong. The Government revalued upwards by 5% against the $A. At the time of the 17.5% devaluation of the $A by the Australian Government the Papua New Guinea Government devalued by 7.5%. This action of the Papua New Guinea Government seem to reflect the relative importance of Australia as a component of the world market as viewed from

Papua New Guinea. The Economic Intelligence Unit (1976) report Australia to be a minor market but a major supplier of Papua New Guinea. In short the Government of Papua New Guinea do appear to administer the exchange rate to maintain the balance of trade.

Furthermore Papua New Guinea make limited use of tariffs and quotas. Generally speaking imports are subject to negligible duty. Substantial duties are placed on items which compete with the few efficient fledgling industry, and also on those considered to be luxuries and used largely by the rather small group of elite indigenes and expatriates, however the range of goods is rather limited. Thus there is little distortion in the market for overseas goods and the exchange controls which were established as a precaution are little used.

It seems the Papua New Guinea economy is an open economy where it is unnecessary to shadow price the imports used in the project.

10.4 LOCALLY PRODUCED GOODS.

Papua New Guinea has traditionally been a laissez-faire economy with respect to the supply of goods. The Government has in general restricted its economic activity to the provision of services. Recently the Government has begin to invest in productive industry and also to regulate the price of some commodities. However investment has taken the form of purchases of equity in private companies and price regulation has been restricted to a few essential items. Thus distortions in the market are limited. It

seems reasonable to adopt the market price as the opportunity cost for locally produced goods.

10.5 CAPITAL.

10.5.1 Approach to Shadow Pricing.

Capital investment reduces capital available for present consumption in order to produce a stream of future consumption. For investment to be worthwhile this future stream of consumption flowing from the investment must exceed in value the present consumption forgone, which is the orpportunity cost of the capital. In cases where the future stream of benefits can be anticipated the particular interest rate implied may be calculated.

Early investments by Government agencies were frequently not formally analysed in economic terms and political processes were the sole determinant of the investment. As governments came to invest more frequently in projects where the benefits accrued in the long term, and the implicit interest rate could be recognized, it became clear that the rate used by Government was in many cases far below those current in the private capital market. Since a considerable part of Government funds are withdrawn from the private sector through taxation, and are thus unavailable for investment, many felt that the divergence in public and private rates of time preference might indicate a sub-optimal allocation of resources between the public and private sectors, and over time. A controversy developed over whether this was in fact the case. When planners made efforts to establish a social rate of time preference for the public sector as an aid to project selection the

controversy was exacerbated. This social rate of time preference is of particular importance in the economic evaluation of plantation projects, because of the long delay between investment and returns.

One view widely supported in the past was that a Pareto optimum arrangement should be encouraged. Mishan (1971) and others who supported this view believed that use of the private market rate by Government was the only way to ensure adequte allocation of resources between the public and private sectors, and over time. On the other hand many noted the distortions introduced to the private market rate by government financial institutions and taxation, the range of rationing devices used, and the great range of private interest rates which resulted. They questioned the efficiency of the private market in resource allocation.

The justification for the divergence between public and private rates is that individuals do want more investments in long term social projects, both for their own benefit and that of others, than is indicated by the private market interest rate. Individuals do not commit more funds of their own however unless others do the same. The market mechanism does not accomodate this need (Marglin, 1963).

The proponents of the private market rate argued in reply for structural changes in Government financial arrangements to encourage private investors to provide this further investment wanted by society as a whole. It was suggested that taxation be withdrawn, and subsidies be provided to private enterprize willing to invest in such projects. However Baumol (1968) then pointed

out that it was impractical to expect these changes. He suggested government use a synthetic rate of return which reflected both societies time preference rate, and the opportunity cost of funds withdrawn from the private sector. Baumol (1968) favoured a rate rather closer to the market rate, partly because this rate was based on more objective grounds.

A more fruitful approach to the problem has been to treat the question of societies time preference, and the opportunity cost of capital, as seperate issues. This approach was forshadowed by Marglin (1967) and others, and developed by Dasgupta and Pearce (1972). Ferguson and Reilly (1976) provide a recent presentation. In this approach the social rate of time preference is used directly, but the capital is shadow priced on the basis of its source. The fact that the opportunity cost of the funds may vary is thus fully recognized, at least in theory. However this approach does not recognize the important fact that project may also modify the distribution of benefits within time.

Azzi and Cox (1970) show that the approach of Dasgupta et al (1972) does in fact lead to a regressive distribution of wealth where taxation is not progressive. This might be a very important consideration for many projects in Papua New Guinea, where government policy suggests a strong social desire to channel benefits to rural areas. However the funds for a plantation project would be drawn from outside the area, and the benefits would accrue in large part to the local residents as they gradually aquire equity. Thus the plantation project is likely to achieve a more equitable distribution of wealth which is in line with government policy. It would be desirable to account this by reducing the shadow price

of capital. However this is difficult to achieve satisfactorily with the available theory, hence distribution effects are not accounted in the shadow price. They are treated in discussion as a secondary benefit.

It was proposed in Chapter 7 that the Plantation Project be financed by funds from 3 sources. In the early years 60% of expenditures are financed by funds from the P.N.G. Development Bank. In later years borrowed funds decline as the relative proportion of planting in new areas declines. No further funds are borrowed from year 28 (see Appendix D). The remaining 40% of expenditures are financed from paid up capital which is held in equal proportions by the Investment Corporation of Papua New Guinea and the Logging Company. In later years the Investment Corporation funds are purchased progressively by the indigenous inhabitants.

The shadow price on funds from these 3 sources is calculated in the following sections. The calculations are based on the work of Ferguson et al.(1976).

10.5.2 Shadow Price of Funds from the Papua New Guinea Development Bank.

The Development Bank has to date obtained its funds largely from the Government budget, and to some extent from loans negotiated with the World Bank (P.N.G. Central Planning Office, 1975). The institution has a brief from the Government to act as a lender of last resort for projects of important social value to the Nation. Thus the funds that are borrowed may be regarded as being withdrawn from investment in government development projects selected at the margin. If r_g is the marginal rate of time preference, and i_g is

marginal social rate of discount then :

$$r_g = i_g$$

Ferguson et al (1976) show that if m_g is the marginal propensity to save in the public sector, the shadow price of funds from the public sector P_g is :

$$P_g = \frac{(1 - m_g)\, r_g + P_g m_g r_g}{i_g} \qquad (1)$$

If $r_g = i_g$ this formula reduces to $P_g = 1$. Thus the shadow price of funds borrowed from the Development Bank was estimated to be 1 Kina per Kina.

10.5.3 Shadow Price of Funds from the Investment Corporation of Papua New Guinea.

The Investment Corporation acts as a government agent in the purchase of equity in private companies. It has recently been authorized to invest in new developments which appear likely to be profitable. (P.N.G. Central Planning Office, 1975).

Ferguson et al (1976) show that if P_p is the shadow price of funds withdrawn from the private sector, r_p is the marginal rate of time preference in the private sector, t is the tax rate, and m_p is the marginal propensity to save in the private sector, then :

$$P_p = \frac{((1 - m_g)r_p + m_g r_g p_g)t + ((1 - m_p)r_p + m_p r_p p_p)(1 - t)}{i_g} \qquad (2)$$

If P_{PIC} represents funds drawn by the Investment Corporation from the private sector.

P_{PIC} may be substituted for P_g and 1 substituted for P_g in equation 2 then

$$P_{PIC} = \frac{r_p(1 - m_p)(1 - t)}{i_g - r_p m_p (1 - t)} \qquad (3)$$

10.5.4 Shadow Price of Funds from the Logging Company.

Funds withdrawn from the Logging Company P_{PLC} have a shadow price of approximately P_p. However some adjustment must be made because some of the profits of this foreign owned firm will be exported and hence be unavailable to the nation for both consumption and investment. If e is the propensity to export out of private income; m_{pe} is the propensity to invest out of private income retained; and provided $P_g = 1$, then by substitution in equation (3)

$$P_{PLC} = \frac{r_p (1 - m_{pe}) (1 - e - t)}{i_g - r_p m_{pe}(1 - e - t)} \qquad (4)$$

10.5.5 Indices which Determine the Shadow Price of Funds.

Profits from the Plantation Project would be subject to the Company tax rate which is believed to be 25%. Thus $t = 0.25$.

To calculate e it is necessary to know the profits earned by small foreign companied in Papua New Guinea, and the profits exported. The profits earned by companies other than the Bougainville Copper Limited were approximately K15 million per annum in 1974 (P.N.G. Central Planning Office, 1975), but there are no statistics available to show the proportion of these profits

which were exported. The profits earned by companies including Bougainville Copper Limited average K281.2 million per annum between 1973 and 1975, and an average of K80.3 million per annum of profits were exported (P.N.G. Bureau of Statistics, 1976). It was estimated that the Government received 40% of the gross profit during this period largely in the form of excess profits tax. Hence e was estimated to be :

$$e = \frac{80.3}{(281.2)\ 0.6} \quad \text{or} \quad 0.48$$

The marginal propensity of small private business to save and invest out of the private income retained is likely to be very high, and m_{pe} was estimated to be 0.9.

It is difficult to estimate the marginal propensity of the Investment Corporation to save and invest out of profits because of the diverse sources and destinations of funds of the organization. A guide was provided by the Investment Corporation Fund, a unit trust operated by the Investment Corporation, which sells the interest in Investment Corporation shares, pays a dividend, and retains part of the surplus as capital appreciation. In 1973-74 and 1974-75 approximately 60% of profits went to dividend and 40% were retained (P.N.G. Central Planning Office, 1975). This indicates an average propensity to save of 0.4. The marginal rate may have been lower. On the other hand the Investment Corporation is likely to have had a higher propensity to invest. Hence m_p was estimated to be 0.4

An estimate of the average return on private investment in Papua New Guinea r_p was based on the performance by the Investment Corporation. In 1973-74 the Investment Corporation

earned 23.5% profit before tax (P.N.G. Central Planning Office, 1975). This figure was adjusted downwards because the profit was abnormally high that year as a result of the then recent re-negotiation of the Bougainville Copper agreement, and also to allow for inflationary effects. Average before tax profit was estimated to be 20%. The allowance for inflation was based on an historical average which was the approach used by Ferguson et al (1976). The inflation rate in Papua New Guinea was 18% in 1973-74, 6.6% in 1971-72, and somewhat less in preceeding years (P.N.G. Bureau of Statistics, 1974; 1975). A reasonable weighted average inflation rate is 7%. Hence r_p was estimate to be 0.13(1).

Ferguson et al.(1976) discussed a number of alternative means to establish the social rate of time preference. They adopted the market rate on Australian securities as the social rate because it was a measure of the cost of funds borrowed for the marginal project. They calculated the appropriate value of i_g to be 0.05 after appropriate adjustment for inflation. As much of the funds used by the Development Bank and other government institutions in Papua New Guinea are raised in a similar way, it seemed reasonable to adopt 0·05 as the estimate for i_g.

The Government have limited investment in productive entreprize. Generally only a total of a few percent of the budget is invested in capital works. (P.N.G. Central Planning Office, 1976). Thus m_g is estimated to be 0.1.

Substantial changes would occur by year 30. It is anticipated Government would progressively tax established industry more heavily, and increase its rate of investment. Rates of profit are likely to fall as investment opportunities become less abundant.

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(1) Equivalent to a profit after tax of 10%

More profits may be consumed directly and a smaller proportion of profits may be exported as equity is transfered from the Logging Company and the Investment Corporation to indigenes. It is estimated that by year 30 the value of the indices will be :

$$t = 0.35$$

$$e = 0.24$$

$$m_{pe} = 0.5$$

$$m_{p} = 0.3$$

$$r_{p} = 0.11$$

$$m_{g} = 0.25$$

10.5.6 Shadow Prices of Capital.

Estimates of the shadow prices of capital discussed were obtained by substituting the estimated values of the indices in equation (2),, equation (3), and equation (4). The results are shown in Table 10.2.

Table 10.2 SHADOW PRICES OF CAPITAL (Kina per Kina).

Year	Source of Funds		
	P.N.G. Development Bank	Investment Corporation of P.N.G.	Logging Company
1	1	8.27	5.35
10	1	6.67	4.68
30	1	3.10	3.18

It seems from Table 10.2 that the shadow price of capital from the private sector in year 1 is high for the Logging Company., and even higher for the Investment Corporation. Logging Company funds have a lower social value because a portion of the funds if not invested in the company would be exported. The estimated shadow price of funds of both sources decreases with time because capital availability would be increasing.

10.6 SOCIAL PRICES OF INPUTS.

The estimates of the social price of imports, locally produced goods, expatriate labour, and capital funds from the Papua New Guinea Development Bank are the market prices. Other inputs which were shadow priced are shown in Table 10.3.

Table 10.3 shows that the social value of unskilled labour increases by a factor of 9 over 30 years whilst the increase is small for both expatriate and indigenous skilled labour.

The schedule of weighed average shadow prices of capital shown in Table 10.3 was obtained for each year by multiplying the shadow price of funds from each source by their percentage contribution and summing. The ratio of funds from the 3 sources is 6 ;2:2 in early years. From year 13 the proportion of planting on new sites begins to decrease until no new sites are planted from year 28 (see Appendix D). Development Bank funds would decrease in proportion, hence the weight for funds from this source is decreasing from year 13, and the weight for the other sources rise in proportion. The weighted average shadow price varies little over the years.

Table 10.3 SHADOW PRICES OF LABOUR AND CAPITAL FROM YEAR 3 TO YEAR 30.

Year	Labour			Capital						
							Shadow price of Capital			
							Weights for multipliers			Weighted Average
	Expa-triate	Indige-nous Proffe-ssional	Unskilled	Develop-ment Bank	Invest-ment Corpo-tion of P.N.G.	Logging Company	P.N.G. Develop-ment Bank	P.N.G. Invest-ment Corpo-tion	Logging Company	
1	1	0.90	0.23	1	8.27	5.35				
2	1	0.91	0.29	1	8.09	5.28	-			
3	1	0.91	0.35	1	7.91	5.20	.60	.2	.2	3.22
4	1	0.92	0.41	1	7.74	5.13	.60	.2	.2	3.17
5	1	0.92	0.47	1	7.56	5.05	.60	.2	.2	3.12
6	1	0.93	0.52	1	7.38	4.98	.60	.2	.2	3.07
7	1	0.94	0.58	1	7.20	4.90	.60	.2	.2	3.02
8	1	0.94	0.64	1	7.02	4.83	.60	.2	.2	2.97
9	1	0.95	0.70	1	6.84	4.75	.60	.2	.2	2.92
10	1	0.96	0.76	1	6.67	4.68	.60	.2	.2	2.87
11	1	0.96	0.82	1	6.49	4.60	.60	.2	.2	2.82
12	1	0.97	0.88	1	6.31	4.53	.60	.2	.2	2.77
13	-	0.97	0.94	1	6.13	4.45	.60	.2	.2	2.72
14		0.98	1.00	1	5.95	4.38	.28	.36	.36	4.00
15		0.99	1.06	1	5.77	4.30	.28	.36	.36	3.91
16		0.99	1.12	1	5.60	4.23	.38	.31	.31	3.43
17		1.00	1.18	1	5.42	4.15	.40	.30	.30	3.27
18		1.01	1.24	1	5.24	4.08	.40	.30	.30	3.20
19		1.01	1.30	1	5.06	4.00	.40	.30	.30	3.12
20		1.02	1.37	1	4.88	3.93	.40	.30	.30	3.04
21		1.02	1.43	1	4.70	3.85	.40	.30	.30	2.97
22		1.03	1.49	1	4.52	3.78	.30	.35	.35	3.21
23		1.04	1.55	1	4.35	3.70	.30	.35	.35	3.12
24		1.04	1.61	1	4.17	3.63	.30	.35	.35	3.03
25		1.05	1.67	1	3.99	3.55	.30	.35	.35	2.94
26		1.06	1.73	1	3.81	3.48	.30	.35	.35	2.85
27		1.06	1.79	1	3.61	3.40	.10	.45	.45	3.25
28		1.07	1.85	1	3.43	3.33	-	.50	.50	3.28
29		1.07	1.90	1	3.25	3.25		.50	.50	3.25
30		1.08	1.97	1	3.10	3.18		.50	.50	3.14

CHAPTER 11

SOCIAL ANALYSIS OF THE PLANTATION PROJECT.

11.1 OUTLINE.

The social analysis begins with estimates of social costs and revenues of the plantation project using the social prices from Chapter 10, and project inputs from Chapter 7. Labour, other material inputs, and capital is the classification of social costs used. They are presented in a balance sheet, together with an estimate of the social net worth of the project. In conclusion the social value of the project,is discussed with reference to the social net worth,and the other important social costs and social benefits which do not appear in the balance sheet.

11.2 SOCIAL COSTS.

The cost of buildings, maintenance, and machinery hire shown in Table 9.3 include both labour and materials. These components have been seperated. It was estimated that labour costs are 13% of building costs (see Appendix D). It was also estimated that maintenance costs of fixed assets were 50% skilled labour costs and 50% materials costs.

Table 11.1 shows the breakdown of the financial costs of building construction, maintenance, and machinery hire into labour and materials costs.

Table 11.1 BREAKDOWN OF BUILDING CONSTRUCTION, MACHINERY HIRE AND ALL MAINTENANCE COSTS INTO MATERIALS AND LABOUR COSTS.*

Year	Building Construction Costs		Maintenance cost of Building's, Machinery owned, Office Furniture Radio Equipment		Machine cost of Machine hire	
	Materials	Labour	Materials & parts	Labour	Materials & parts	Labour
1						
2	-	-	-	-	-	-
3	10,358	1,548	4,509	4,509	11,696	747
4	11,500	1,718	4,834	4,834	11,795	753
5	10,997	1,643	5,066	5,066	13,276	847
6	10,997	1,643	5,530	5,530	13,809	428
7	10,997	1,643	5,531	5,531	13,468	860
8	12,138	1,814	5,856	5,856	14,426	932
9	10,997	1,643	5,030	5,030	14,740	941
10	10,997	1,643	5,030	5,030	14,857	948
11	12,393	1,852	6,950	6,950	32,562	2,078
12	12,393	1,852	6,950	6,950	32,737	2,090
13	12,393	1,852	6,950	6,950	34,945	2,231
14	12,393	1,875	7,106	7,106	38,547	2,460
15	12,393	1,875	7,106	7,106	38,611	2,465
16	13,922	2,082	7,681	7,681	70,229	4,483
17	13,922	2,082	7,682	7,682	88,531	5,651
18	14,104	2,108	7,632	7,632	88,724	5,663
19	14,104	2,108	7,632	7,632	89,410	5,707
20	14,104	2,108	7,632	7,632	89,625	5,721
21	14,104	2,108	7,891	7,891	89,775	5,730
22	14,104	2,108	7,891	7,891	83,393	5,322
23	14,104	2,108	7,891	7,891	83,546	5,333
24	14,104	2,108	7,891	7,891	83,696	5,342
25	14,104	2,108	7,891	7,891	83,859	5,353
26	14,104	2,108	7,891	7,891	83,966	5,360
27	14,104	2,108	7,891	7,891	71,428	4,559
28	14,104	2,108	7,891	7,891	65,798	4,200
29	14,104	2,108	7,891	7,891	65,798	4,200

* All labour costs shown relate to skilled indigenous workers.

Table 11.2 SOCIAL COSTS OF LABOUR AND MATERIAL INPUTS EXCLUDING LAND (Kina)

Year	Labour			Materials
	Skilled Indigene	Unskilled	Expatriate	
1				
2	-	-	-	-
3	24,508	3,864	51,480	42,567
4	41,072	7,341	51,480	44,298
5	43,300	8,912	40,040	46,003
6	43,816	10,290	40,040	49,718
7	44,735	11,477	40,040	49,344
8	53,387	13,584	40,040	52,238
9	52,923	15,289	22,880	50,420
10	53,487	16,600	22,880	50,548
11	58,439	30,863	22,880	81,044
12	59,060	42,177	22,880	81,236
13	72,552	45,052	-	83,769
14	73,713	46,899		86,583
15	74,473	49,713		86,654
16	104,562	83,690		128,312
17	106,904	128,003		145,378
18	107,959	148,151		151,800
19	108,008	153,901		152,500
20	109,093	163,557		153,021
21	109,394	170,721		153,186
22	110,004	163,374		146,155
23	110,084	160,873		146,334
24	111,095	167,100		146,499
25	112,176	173,328		146,678
26	113,253	179,555		145,894
27	112,319	152,286		132,684
28	112,319	121,084		126,390
29*	112,319	114,794		124,747

* Beyond year 29 costs are relatively stable.

The costs of building construction shown in Table 11.1 include the provision for depreciation of project buildings (1). Insurance is also included. It is assumed to be an estimate of the extra materials and labour that would be used due to unforseen events. The labour component of machine hire is assumed to consist of operator costs. Maintenance would be provided by the Logging Company. Hence the labour involved would be external to the project and is treated as part of the cost of materials.

The estimates for the costs of skilled labour shown in Table 11.1 were combined with the seperate costs of labour in Table 9.3. Contingencies of 10% were then included to allow for labour payments such as leave and sick pay (see Appendix D). The social costs of skilled labour were then obtained by multiplying the estimated labour payments by the appropriate shadow prices from Table 10.3. The social costs of expatriate and unskilled labour input were obtained directly from the costs shown in Table 9.3, and the appropriate shadow prices in Table 10.3.

The costs of materials shown in Table 11.1 were combined with materials costs in Table 9.3 (see Appendix D). Contengencies of 10% were included to allow for extra material costs that would be incurred. These materials costs are the social costs of materials because the shadow price of materials is 1. The material inputs are summarized in Appendix D.

Table 11.2 shows the social value of the labour and material inputs to the project. It seems that the estimated social costs of labour and materials are little different from the estimated financial costs except in the case of unskilled

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(1) The substitution for some capital outlays of annual depreciation and interest charges on average capital (at a rate of 10%) is a departure from the usual procedure of cash flow analysis. The procedure followed allowed the present worth of cash flows in later rotations to be calculated more easily.

labour. In the early years unskilled labour has little social cost. However it is estimated that by year 15 the social costs of labour exceed the financial costs. These social costs continue to increase relative

11.3 SOCIAL BALANCE SHEET OF THE PLANTATION PROJECT.

Table 11.3 shows the estimated social value of all material inputs and revenues of the project, not including land. The social value of the revenues is the stream of stumpages from Table 8.15, multiplied by the shadow price of revenues which is assumed to be 1. It seems from Table 11.3 that on balance the project would require capital inputs for most of the first 20 years. The project does not consistently produce capital surpluses until year 26.

An estimate of the social value of the project was obtained by first multiplying the stream of positive and negative balances balances in Table 11.3 by the appropriate shadow price. The shadow price for capital produced by the project which makes up the positive balances is 1. Negative balances were multiplied by the appropriate weighted average shadow price of capital from Table 10.3. The social worth in year 3 of each annual capital balance valued in social terms, was obtained by discounting at 5% which is the social rate of discount. (see Chapter 10).

Table 11.4 shows the social balance and the social worth in year 3 of each annual capital balance. The capital balance shown for year 29 is the capitalized value of the stream of balance beyond year 28. This stream would be relatively stable. The social worth in year 3 for this stream also appears in Table 11.4.

Table 11.3 SOCIAL BALANCE SHEET OF LABOUR AND MATERIAL EACH YEAR EXCLUDING LAND.

Year	Produced*	Used		Balances	
		Labour	Other Physical	Negative	Positive
1					
2		-	-		-
3		79,852	42,567		122,419
4		99,893	44,298		144,191
5		92,252	46,003		138,255
6		94,146	49,718		143,864
7		96,252	49,344		145,596
8		107,011	52,238		159,249
9		91,092	50,420		141,512
10		92,967	50,548		143,512
11	-	112,182	81,044		193,226
12	(-)22,967	124,117	81,236	-	228,320
13	232,486	117,604	83,769	31,113	-
14	232,486	120,614	86,583	25,289	-
15	263,218	124,186	86,654	52,378	-
16	261,833	188,252	128,312	-	54,731
17	272,834	234,907	145,378	-	107,452
18	286,295	256,110	151,800	-	121,615
19	286,295	261,909	152,500	-	128,114
20	265,995	272,650	153,021	-	159,676
21	426,989	280,115	153,186	-	6,312
22	432,589	273,378	146,155	13,056	-
23	432,589	270,957	146,334	15,298	-
24	432,589	278,195	146,499	7,895	-
25	413,067	285,504	146,678	-	19,115
26	700,788	292,808	145,894	262,086	-
27	866,373	264,605	132,684	469,084	
28	866,373	233,403	126,390	506,580	
29*	866,373	227,113	124,747	514,513**	

* Beyond year 29 annual balances are relatively stable.

Table 11.4 SOCIAL VALUE AND SOCIAL NET WORTH IN YEAR 3 OF ANNUAL CAPITAL SURPLUSES AND DEFICITS OF THE PLANTATION PROJECT.

(Kina)

Year	Social Value of Capital Balance		Social Worth in Year 3 of Annual Balance	
	Surplus	Deficit	Positive	Negative
1				
2		-		-
3		394,189		394,189
4		457,085		406,748
5		431,356		391,253
6		461,662		398,801
7		439,700		361,742
8		472,970		370,580
9		413,215		308,347
10		411,879		292,715
11		544,897		368,808
12	-	632,446	-	407,680
13	31,113	-	19,101	-
14	25,289	-	14,789	-
15	52,378	-	29,166	-
16	-	187,727	-	19,556
17		351,368		177,465
18		389,168		128,441
19		399,716		125,640
20		485,415		145,312
21	-	18,747	-	5,345
22	13,056	-	3,545	-
23	15,298	-	3,956	-
24	7,895	-	1,944	-
25	-	56,198	-	13,181
26	462,086	-	58,546	-
27	469,084		99,796	
28	506,580		102,641	
29*	514,513		992,845**	

* Capital surplus is reasonably stable beyond year 29

** Capitalized value of surpluses from year 29

It seems from Table 11.4 that the social values of all capital balances to year 20 are large and negative. Large positive balances are not generated until year 28.

The social net worth of the project in year 3, obtained by summing the social values of all annual balances discounted to year 3 is :

K(-)3,069,477.

11.4 SOCIAL VALUE OF THE PLANTATION PROJECT.

The present net worth calculated in the previous section is not a complete index of the social value of the project, being largely an estimate of the social value of resources produced and consumed directly. There are frequently indirect effects and secondary effects which warrant scrutiny. While detailed analysis of these factors is largely beyond the scope of this essay, a brief review of them seems desirable.

11.4.1 Future Development without Plantations.

If the plantations are not established a chip mill would not be constructed because supply would be inadequate. A forestry based strategy would most likely be restricted to the establishment of a sawmill and to the associated sawlogging in the rainforests.

Table 11.5 shows an estimate of the direct and indirect employment generated by operations associated with a sawmilling industry of 70,000 m^3 log per annum.

Table 11.5 DIRECT AND INDIRECT EMPLOYMENT AS A RESULT OF A SAWMILLING INDUSTRY.

Industry	Direct Employment*	Employment Multipliers*	Total Employment
Sawmilling	40	1.86	74
Road transport	50	1.24	62
Forestry			
Roading	100		
Harvesting	150	2.22	555
Total			691

* Based on Ferguson (1972)

The estimates of employment shown in Table 11.5 are personal estimates. The employment multipliers are those calculated by Ferguson (1972) based on the work of Parker (1967). The employment multipliers which relate to the West Australian economy may be slightly large because there are fewer linkages to service industry in the Northern District. However the total employment shown in Table 11.5 should be a reasonable estimate of the total employment generated both directly and indirectly by the sawmill development.

Thus approximately 700 people would be employed in the District as a result of sawmill operations. Although substantial this number is small in comparison with the number unemployed (see Chapter 3). Moreover in the first instance many of those employed in the sawmill would come from outside the district as relatively few skilled personal are available locally. Therefore

the development would not greatly alter the local employment situation.

The income and distribution effects of the sawmill development may have relatively more effect on the situation. Although most profits and the Government share of royalties and taxes would leave the District, a substantial proportion of the value added by these operations would remain in the form of labour payments and royalties. Of this income much of the labour payments would be spent in Popondetta. This would benefit the business community. However a proportion would remain in the hands of rural people as royalties.

Localities where logging occurs would be greatly changed. For example extension of the road network to previously relatively innacessible areas would reduce transport costs and encourage local people to enter cash cropping. Moreover some local individuals would receive valuable training in the operation and repair of equipment and vehicles. At the same time the present forest structure would be progressively destroyed, and the present social harmony would be upset to some extent by the entry to the area of large numbers of workers.

These changes should not be included in accounting the costs and benefits of the plantation project.

11.4.2 Indirect and Secondary Effects of the Plantation Project.

In the past planners paid most attention to the direct effects of projects. Indirect effects of projects often seem to have been overlooked. However the importance of indirect costs was

gradually realized (see Chapter 2) and account was taken of these in planning this project. The plantation project was planned to ensure there would be minimal interference with the rights of local people and with their life styles. Planned changes would tend to strengthen the local customary organization, and provide greater opportunities for individual satisfaction (see Chapter 7).

There would also be indirect benefits resulting from an increase in the scale of local services. For example the cost of transport is likely to fall and this would provide useful savings for local people. Plantation establishment does not lead to any substantial extension of the road network. Thus the indirect benefits would be in general far less than those for rainforest logging. There would be some loss of hunting land of limited productivity but rent payments would more than offset these costs.

Secondary effects of the plantation project are far more important, particularly those relating to the chipmill and associated rainforest logging which would follow establishment of plantations. There are clearly some costs incurred in the process of logging the rainforest, especially for chipwood. Sawlogging largely destroys the structure of the rainforest but a substantial proportion of the flora and fauna can survive. Chipwood removal results in almost total clearing of the original vegetation, with consequent risk of soil erosion and deterioration of water quality especially in the Kumusi-Saiho area. These costs can be reduced by careful control of operations and use of reserves. Nevertheless some costs would be incurred.

On the other hand the secondary benefits of the plantation project would be very substantial. Table 11.6 shows the

estimated number of employees engaged in the plantation project, the harvesting and transport of chipwood from the plantations and rainforest, and in the chipmill itself.

Table 11.6 EMPLOYMENT OF LABOUR IN THE PLANTATION PROJECT, HARVESTING AND TRANSPORT OPERATIONS, AND CHIPMILL IN SELECTED YEARS (man years)***

	Skilled			Unskilled		
Year	9	19	29	9	19	29
Plantations	14*	27*	27*	32**	240**	88*
Harvesting and Transport						
Plantations	-	66*	199*	-	67*	210*
Rainforest		198		-	191	-
Office		50	50	-	-	-
Chipmill						
Mill		25	25	-	5	5
Office		10	10	-	-	-
Total	14	376	311	32	503	294

* Estimated directly (see Chapter 7, Chapter 8, and Chapter 9)

** Labour provided by part time workers.

*** It was assumed the labour for building the main extensions to the road network would be accounted to the sawlogging operation.

The estimates shown in Table 11.6 without an asterick were based on the estimated numbers of employees at Japan New Guinea Timber Limited at Madang.

Table 11.6 shows the estimated increase in employment when harvesting and transport and chipmilling operation are included to be x3.29 times the direct employment in plantations in year 19, and x5.26 times direct employment in year 29. Were the additional employment in ancillary industry to be included these figures would be even higher. In the Northern District situation it seems the plantation project would act as a catalyst for the employment of substantial numbers of people.

Income generated by a plantation project depend to a large extent on the linkages of the plantation sector to other sectors of the economy. Table 11.7 shows the direct and indirect purchases by a selection of industries in Papua New Guinea in 1970. Specific data on the transactions associated with forestry plantation, log transport, and chipmilling are not available, but the plantation, transport and communications, and sawmilling and joinery sectors respectively should have similar linkages. In Table 11.7 the sectors of industry supplying inputs have for simplicity been collapsed into a few large sectors.

It seems from Table 11.7 that forestry plantations would have backward linkages mainly to the private services and transport sectors. These backward linkages of plantations are comparable to those of the small holding sector, though somewhat less than those for livestock. However the plantation project would have strong linkages to the manufacturing sector because of its relationship to the chipmill. The importance of the special link to

chip manufacturing can be estimated from the direct and indirect forward linkages of the sawmill and joinery sectors. These include strong forward linkages to manufacturing, building construction and private service industries. It seems the plantation project would have extensive secondary effects on District income.

Table 11.7 INDIRECT AND DIRECT PURCHASES BY SELECTED INDUSTRIES IN P.N.G. 1970.

Sector Supplying Inputs	Purchases per unit of sales to final demand					
	Plantations	Small holders	Livestock	Fishing Forestry Extractive	Transport & Communications	Sawmilling & Joinery
Agriculture	-	-	.04	-	-	-
Extractive	-	-	-	-	-	.20
Manufacturing	.04	.21	.04	.03	.17	.05
Building & construction	.01	-	.01	.01	-	.04
Transport & Communications	.08	.03	.06	.05	-	.09
Private Services	.15	.07	.26	.17	.14	.19
Pbublic Services	.01	-	.06	.08	.01	.03
Total	.29	.31	.47	.34	.32	.60

Source : Calculated from Parker (1973).

The direct and indirect effects of the plantation project on the balance of payments are suggested by the import

content of the final product of the plantation and woodchip industries. The final product of these and other selected industries is shown in Table 11.8.

Table 11.8 IMPORT CONTENT OF FINAL PRODUCT FOR VARIOUS INDUSTRIES 1970 AND 1978.*

Industry	Import content of 1 Unit final Product	
	1970	1978
Plantations	0.10	0.10
Small holder	0.05	0.05
Clothing and textiles	-	0.36
Beverages	0.31	0.24
Road transport	0.21	0.21
Wood chips	-	0.11

Source : Selected data from Parker (1973).

Table 11.8 shows the import content of produce from the average plantation. Produce from forestry plantation may have a slightly higher import content because many operations are mechanized. Nevertheless forestry plantations compare favourably as earners of foreign exchange with such industries as clothing and textiles and beverages. If forward linkages to wood chip industry are considered forestry plantations are seen in an even more favourable light. The wood chip industry also has a low import content. Thus forestry plantations which lead to chipmill production would seem to offer great potential for imporving the balance

of payments. The small holder sector has very low import content but in general forward linkages to that part of the manufacturing sector with low import content would be weak.

The plantation project would also have very favourable distributional effects. A large proportion of the value added in growing the plantations would be paid out in the form of wages and salaries (see Table 9.3). In later years more tham half of these payments would be paid to large numbers of part time workers. This would be very satisfactory from the point of view of government policy (see Chapter 2). Moreover these favourable distributional effects would extend to the chipwood harvesting and transport operations which would be dependant for their existance on the plantation project. The value added in these industries would go largely to payments for equipment. However wages are a major cost (see Table 8.14). In the early years these wages would be paid largely to workers from elsewhere and much would be spent in Popondetta. In later years however,when most jobs had been localized, most of these payments would accrue to residents of rural areas of the Northern District.

It is difficult to reach a conclusion on the social value of the plantation project. The analysis clearly shows the project is not worth while from the nations viewpoint on the basis of the direct effects. The indirect effects are limited and provide no justification for changing this evaluation. However if Government believed that the problems of employment and lack of incomes in the Northern District were severe,and required urgent attention,then it would be possible to justify the plantation project on the basis of its secondary effects. The secondary

effects shown are very substantial even though no effort has been made to examine the ramification of the plantation and chipmilling operations throughout the local private business sector.

CHAPTER 12

CONCLUSIONS.

The basic aim of this essay was to demonstrate a methodology for the planning and analyses of plantation projects located in developing countries. The Northern District of Papua New Guinea was selected as a suitable location and a likely forestry development strategy for this District was outlined. The plantation project which forms part of the strategy was used to demonstrate the methodology.

The review of factors affecting the plantation plan shows that the range of conditions in planning plantation projects in developing situations is far wider than for similar projects in developed situations. In developed countries social considerations and institutions may often be largely ignored. The social conditions are generally stable, and the planning methods are compatible having been developed in similar circumstances. In developing countries like Papua New Guinea social conditions are changing rapidly.

This essay has shown the importance of recognizing the important social characteristics of the locality and using these in formulating the basic framework of the plantation project. Careful examination of recent history, government policy, and sociological and related research, enabled the most important social characteristics to be identified and taken into consideration. Northern District village people differ in fundamental

ways from people in developed areas. They place far greater value on sharing and on group co-operation, particularly in regard to decision making, and the use of land. The village people are very sensitive on matters relating to their independance and to their individual rights. Many are almost totally dependant on subsistance agriculture for their existence.

This essay demonstrates a way to accommodate these social needs in planning the plantations. This accommodation was achieved by dispersing the plantations and organizing the plantations on a group basis within the boundaries of group land.

The financial analysis provides a demonstration of how to approach the determination of the financial viability of a plantation project. The substantial negative value obtained for the present net worth K(-)619,218 suggests the project would not be financially viable in its present form unless stumpage values were greater than estimated. It seems a rise of 10% in the real value of stumpage before harvesting was begun in year 13 seems likely to ensure the projects viability. A 10% rise in stumpage is approximately equivalent to a rise in the real value of chips c.i.f. Japan ports of approximately 2%

It should be borne in mind that the calculated present net worth is based on analyses which are somewhat simplified and which do have some weaknesses due to the difficulties of obtaining data. In particular the estimated chip mill door value of chipwood is almost certainly optomistic. Hence the stumpage estimates for plantation wood and the estimated present net worth are also likely to be optomistic. It should be noted that the transport costs

which dominate the costs of logging operation are probably pessimistic and this would to some extent offset the effect of a mill door value revised downwards.

The results of the social analyses were more difficult to interpret. On the one hand a quantification of the direct effects of the project resulted in a very large negative present net worth of K(-)3,069,477 and this is based on optomistic stumpage provisions. Consideration of indirect effects made little difference to the result even though the project was planned to minimize indirect costs. On the other hand it seems the project could generate extensive secondary benefits in the form of employment and income. The project also appears likely to have favourable effects on the balance of trade and the distribution of wealth. Taken together the plantation and chipmill projects could provide the industrial, economic, and social structure, needed to attract complimentary industry to the area. Such an economic catalyst is unlikely to be provided by the private sector without substantial encouragement. The extent of these secondary benefits and the value placed on them would determine whether a subsidy to the plantation company to ensure its viability is justified in the national interest.

As noted earlier the data used in parts of this study leave much to be desired. Nevertheless better data on prices, wages, other costs, and present and proposed land tenure and company law, would probably be easily obtained in Papua New Guinea and would enable the basis of the analyses to be improved.

The most important information required but which may be difficult to obtain relates to stumpage values and includes ;

(a) Price of E. deglupta chip f.o.b. N. Coast Papua New Guinea; or alternatively the bulk, basic density, and price c.i.f. Japan ports, of E. deglupta chip.

(b) Average green weight of E. deglupta shortwood at likely rotation ages.

(c) Processing costs and material losses incurred during debarking chipping and storing E. deglupta shortwood.

(d) Acceptability of E. deglupta bark as chip material.

(e) Time and costs studies of truck transport of plantation shortwood, including down time estimates, made under local conditions.

Although plantation company costs are not subject to the uncertainties associated with revenues some matters warrant further investigation. These include the determination of reliable methods for the protection of plantation established in grassland of the lowlands. Reliable methods and comparative costs for the establishment of E. deglupta plantation on grassland and other site types. The analyses in this study suggest labour intensive methods should be used provided financial penalties incurred are not very substantial.

Locations selected in other Districts of Papua New Guinea and elsewhere for plantation projects for chipwood production are not likely to have the same characteristics as the Northern District. Nevertheless this study does show what the most important considerations would be for these projects. Financial viability of plantations is likely to be determined by the price of chipwood and this is very greatly affected by the costs of transport. It seems very important to locate plantations as close to the port as possible. The social value depends largely on the extent to which a plantation project is likely to catalyse the economic development of an area.

APPENDIX A

APPENDIX A (cont.)

TABLE A1 SCHEDULE OF TOTAL LOG INPUTS TO MILLS (thousand m^3)

Year	Sawmill	Chipmill
1	-	
2	5	
3	20	
4	43	
5	55	
6	65	
7	73	
8	73	
9	73	
10	73	-
11	73	77
12	73	128
13	73	228
14	73	328
15	73	390
16	73	390
17	73	400
18	73	400
19	73	400
20	73	400
21	73	400
22	73	400
23	73	400
24	73	400
25	73	400
26	73	400
27	73	407
28	73	407
29	73	407
30	73	407
31	73	407
32	73	407
33	73	407
34	73	407
35	73	407
36	73	407
37	73	407
38	73	407
39	73	407
40	68	403
41	23	363
42	3	363
43*	-	363

* Beyond year 43 annual log inputs remain unchanged

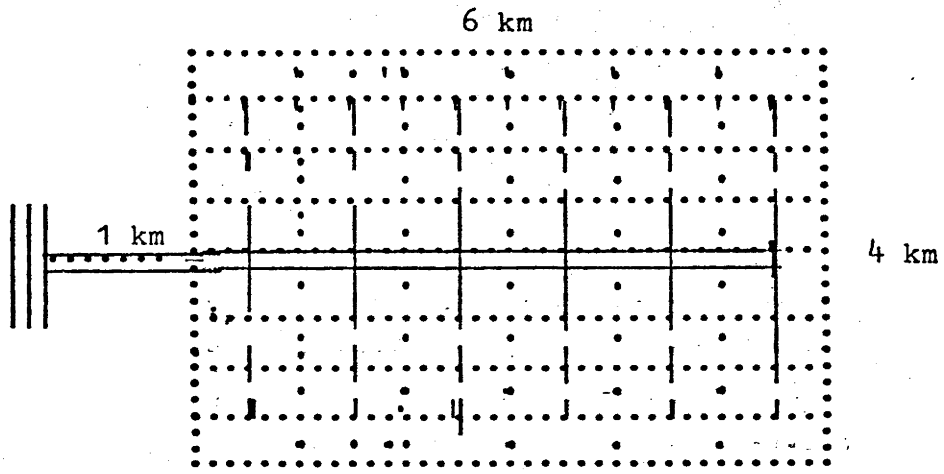
APPENDIX A (cont.)

TABLE A.2 CONSUMER PRICE INDEX (JUNE 1971 = 100)

Date	Madang	Port Moresby	Average	Increment
May 1971	98.8	99.2	99.0	
" 1972	105.4	105.8	105.6	6.6
" 1973	111.1	112.5	111.8	6.2
" 1974	145.9	141.9	143.9	32.1
" 1975	160.3	152.1	156.2	12.3
" 1976	171.0	166.4	168.7	12.5

Source: P.N.G. Bureau of Statistics (1976)

APPENDIX A (cont.)



Legend:

represents road, category 2
represents road, category 3
" " " 4
" " " 5
represents firebreak

FIGURE A.1 MODEL PLAN OF A PLANTATION UNIT

Details relative to the model are:

Area of plantation unit	2400 ha
Area of compartment	100 ha
Area of block	25 ha

Length of road, category 3	7.5 km
" " " " 4	6 km
" " " " 5	12 km
" " " total	25.5 km

Length of firebreak	74.5 km

APPENDIX A (cont.)

TABLE A.3 SCHEDULE OF PLANT PRODUCTION AT SEREMBI NURSERY

Year	Plants required (thousands)
1	-
2	-
3	360.6
4	360.6
5	392.8
6	392.8
7	492.8
8	424.3
9	424.3
10	424.3
11	648.7
12	648.7
13	648.7
14	648.7
15	648.7
16	1041.4
17*	1272.8

* Beyond year 17 the level of annual production is unchanged

APPENDIX A (cont.)

TABLE A.4 SOME DETAILS OF TIME SPENT BY HEAVY EQUIPMENT DURING PLANTATION OPERATIONS*

Operation	Equipment item	Rate of working
Road construction	Crawler tractor	2 passes at 2km per hr.
	Grader	2 passes at 4km per hr.
Road maintenance	Grader	2 passes at 4 km per hr. over 10% of road network (annually)
Firebreak establishment and maintenance	Crawler tractor	1 pass at 4km per hr. (annually)
Ploughing	Crawler tractor	2.7 km per hr. (4 m strip)
Heap/burn/heap		
rainforest sites	Crawler tractor	2.34 ha per day
replanting sites	" "	6.90 < ha per day
Rip planting line	Crawler tractor	3 km per hr. (2.7km per ha)

* Personal estimates based on discussion with other foresters

APPENDIX A (cont.)

TABLE A.5 SOME SPECIFICATIONS OF VEHICLES AND MACHINERY USED IN PLANTATION ESTABLISHMENT MAINTENANCE, AND IN PLANTATION LOGGING AND TRANSPORT OPERATIONS

Item	Description
Station sedan	Toyoto Land Cruiser; 4x4.
Utility	Toyoto; 4x4, 1 tonne.
Motor cycle	Suzuki; trail, 125cc.
Water tanker	Daihatsu; 6x4, 10 tonne.
Plough	Heavy duty, disc, adjustable width from 3m to 4m.
Agricultural tractor	Wheeled, 60 HP.
Plant carrier	Trailer, steel tray body, single axle.
Snig unit	International Harvester; Industrial tractor, wheeled, 77 HP, half tracks, cab, weights, double drum winch, winch butt pan, protective gear.
Truck for shortwood transport	Daihatsu; 6x4, 10 tonne, tray body. Fittings for hydraulic loader, logging.
Hydraulic loader on truck	Cranab 4000 series.
Crawler tractor	Cat. D6; blade, single tyne.
Grader	Cat. 120G; cab.
Chainsaw	Medium.

APPENDIX A (cont.)

TABLE A.6 GRADER HIRE TIME FOR PLANTATION ROAD ESTABLISHMENT AND MAINTENANCE (hours).

Year	Road construction grassland sites	Road maintenance	Total
1			-
2	-		-
3	2	-	2
4	2	1	3
5	2	1	3
6	2	1	3
7	2	1	3
8	2	1	3
9	2	3	5
10	2	2	4
11	2	2	4
12	2	3	5
13	2	3	5
14	1	3	4
15	1	3	4
16	1	3	4
17	1	4	5
18	1	4	5
19	-	5	5
20		5	5
21		5	5
22		5	5
23		6	6
24		6	6
25*		7	7

* Beyond year 25 annual grader time remains unchanged

APPENDIX A (cont.)

TABLE A.7 ASSUMPTIONS MADE ABOUT JUNIOR STAFF AND HOUSING MADE AVAILABLE

Year	3	5	11	16
Single males	3	3	4	4
Single females	1	1	1	2
Married males	1	2	2	3
Houses made available	3	4	5	6

The females shown in Table A.7 would be staff typists. Three of the four drivers and clerks initially engaged would be single. Later most would be married.

APPENDIX B

APPENDIX B (cont.)

Calculation of the freight adjustment to the value of mixed temperate hardwood chip f.o.b. S.E. Australia to obtain f.o.b. value N. coast P.N.G. It is assumed the destination of chips is Japan.

Formula: $P_f = F_e (1 - S_e D_e / S_\mu D_n)$

where P_f is the reduction in freight for chip from N. Coast P.N.G. relative to chip from S.E. Coast Australia

F_e is the freight cost in $A per D.B.U. for mixed temperate eucalypt chip from S.E. coast Australia to Japan. (Estimated to be $A30).

S_e and S_μ are the estimated number of round trips made by a ship from S.E. Australia and N. Coast P.N.G. respectively to Japan per annum.

D_e and D_n are the basic densities of mixed temperate chip and chip from N. Coast P.N.G.

Source: Phillips and Logan (1977)

This formula was used to calculate the adjustments to the value of mixed tropical hardwood chip (basic density 484 kg per m^3, o.d.w.), mixed temperate eucalypt chip (basic density 563 kg per m^3, o.d.w.), and *E. deglupta* chip (basic density 557 and 346 kg per m^3. o.d.w.) North Coast Papua New Guinea. The ratio D_e/D_n was estimated to be 10/14, and F_e to be $A30 by Phillips and Logan (1977).

APPENDIX B (cont.)

TABLE B.1 CATEGORIES OF ROAD USED DURING PLANTATION LOGGING

Category	Width (m)	Surface	Structural material bridges & culverts
1 Main road	10	crushed rock	concrete
2 Access road	10	" "	"
3 Primary road	8	gravel	"
4 Secondary	6	formed earth	log
5 Skidding trails	4.5	" "	log

Source: Based on FAO (1974a)

TABLE B.2 AVERAGE ROAD SPEED BY LOG TRUCKS ON VARIOUS ROAD CATEGORIES

Category	Average speed (kilometre per hour)
1	50
2	40
3	40
4	30
5	30

Source: Based on FAO (1974a)

APPENDIX B (cont.)

FACTORS OF GENERAL IMPORTANCE IN DETERMINING THE PRODUCTION ESTIMATES OF PLANTATION LOGGING AND TRANSPORT OPERATIONS

Soil is volcanic ash. Road sideslopes of 10^{o} might be encountered but logging slopes would be negligible. Annual rainfalls are high (3378 mm av.). Minimum mean monthly rainfall is 127 mm and maximum mean monthly rainfall is 430 mm (Haantjens, 1964). Drainage on these soils is good.

E. deglupta would be planted at 730 t.p.ha with a spacing of 3.7 m x 3.7 m after Dunn et al. (1974). At rotation age (10 years) the average tree was assumed to have the following dimensions:

Height	29.4 m
Diameter breast height	20.3 cm
Merchantable volume	0.34 m^3

The trees would have relatively few branches. The understorey would be sparse. Merchantable volume at rotation age was assumed to be 250 m^3 per hectare after Dunn et al. (1974).

APPENDIX B (cont.)

TABLE B.3 SOME DETAILS OF THE PRE-LOGGING SURVEY OPERATION

Factors of production per team		
	Utility vehicle	
	Survey equipment	
	Supervisor level 2 (1)	
	Labourers (2)	
	Time *	
	Hours per day at work	(8)
	Hours per day effective	(7.5)
	Vehicle hours per day	(3)
Objectives		
	Locate logging obstacles	
	Mark coupe boundaries	
Production estimates*		
	20 ha. per day	
	L2 supervisor	0.05 man/days per ha
	Labour	0.10 man/days per ha
	Utility vehicle	0.15 hours per ha

* Personal estimates

APPENDIX B (cont.)

TABLE B.4 SOME DETAILS OF THE SHORTWOOD PRODUCTION OPERATION

Factors of production per team

Medium power saw (1)

Chainsaw operator (1)

Labourer (1)

Time**

Hours per day at work (8)

Hours per day effective (6)

Machine hours per day (4)

Operation

Fell with power saw

De-branch with power saw

Buck to 6 m with power saw

Production estimate*

Sub-operation	Minutes per tree Man	Machine	Hours per m^3 Man	Machine	Team hours per m^3	m/days per m^3
Fell	1.75					
Debranch	2.00					
Buck	1.05					
	4.80					
Corrections						
Slope -4%	-0.19					
Temperature +20%	+0.96					
	5.6	2.8	0.27	0.14	0.28	0.07

* After FAO (1974b)

** Personal estimate

APPENDIX B (cont.)

TABLE B.5 SOME DETAILS OF THE SNIGGING OPERATION

Factors of production per team

Snig unit (1)

Driver/operator (1)

Labourer (2)

Time **

Hours at work per day (8)

Hours at work effective (7)

Load size **

3 trees

15 piece
Average length 6 m

Average l.e.d. 12.5 cm

Average volume 1.03 m^3

Operation

Labourer chokes pieces

Driver/operator winches logs to butt pan

drives along row to roadside

Labourer unhitches logs at right angles to road

Driver/operator returns along row

Production estimate*

Round trip time 18 minutes

$$RTT = TT + \frac{MSD \times 2}{V}$$

Travel time 12.5 min.
Mean skidding distance 250 m
Average speed 90 m/min

Machine time 0.29 hrs per m^3

Driver/operator 0.04 man/days per m^3

Labour 0.08 man/days per m^3

* Based on FAO (1974b)
** Personal estimates following discussion with Groves (1976)

APPENDIX B (cont.)

TABLE B.6 SOME DETAILS OF THE SHORTWOOD LOADING TRANSPORT, AND UNLOADING OPERATIONS

Factors of production per team

Haul unit (1)

Driver/operator (1)

Hours of shift (10)

Hours operational (8)

Mass of timber *E. deglupta* (estimated) 1000 Kgm per m^3

Timber location (roadside end on)

Timber volume on ramps 9.25 m^3 every 3.7 m

Average round trip 160 km

Average road speed both ways 47 km per hour

Average round trip travel time 3.4 hours

Average load time 0.5 hours

Average unload time 0.1 hours

Operation

Truck driver loads using truck mounted hydraulic loader
Drive load to mill
Load pushed off truck at mill by front end loader

Production estimate*

Sub-operation	Truck & loader (hours per m^3)	Labour (m.hours/m^3)	(m.days/m^3
Load & unload	0.06	0.06	
Travel both ways	0.34	0.37	
	0.39	0.49	0.06

*Based on FAO (1974a)

APPENDIX B (cont.)

TABLE B. 7 MACHINERY INPUTS TO THE PLANTATION LOGGING OPERATIONS (hours)

Year	Utility	Chainsaw	Snig tractor	Log truck	Truck mounted crane
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12	-	-	-	-	-
13	60	14000	29000	34000	5000
14	60	14000	29000	34000	5000
15	67	15680	32480	38080	5600
16	67	15680	32480	38080	5600
17	67	15680	32480	38080	5600
18	73	16940	35090	41140	6050
19	73	16940	35090	41140	6050
20	73	16940	35090	41140	6050
21	111	25900	53650	62900	9250
22	111	25900	53650	62900	9250
23	111	25900	53650	62900	9250
24	111	25900	53650	62900	9250
25	111	25900	53650	62900	9250
26	178	41580	86130	100980	14850
27*	218	50820	105270	123420	18150

* Beyond year 27 annual machinery inputs remain unchanged
The estimates shown in Table B.8 are based on the production estimates in Appendix B

APPENDIX B (cont.)

TABLE B.8 DELIVERED PRICE OF PLANTATION HARVESTING EQUIPMENT AND VEHICLES

	Light grader	Crawler tractor	Snig tractor	Chainsaw	Log truck	Hydraulic loader
			($A)			
Cost in Australia **	75,000	85,000	18,000		40,000	12,000
Sales tax %	-	-	-		15	NK
* Australian import duty %	20	-	20		22.5	NK
* Residual	60,000	85,000	14,400		26,350	-
			(kina)			
* Residual	52,800	74,800	12,672		23,188	-
* Import duty P.N.G. %	-	-	-		10	NK
* Delivery cost P.N.G. %	2	2	2		2	NK
Delivered cost P.N.G.	55,856	76,296	12,925	500*	26,017	8,000*

NK = Not known; * Personal estimates
** Based on enquiries at dealers

APPENDIX B (cont.)

TABLE B.9 OWNING AND OPERATING COSTS AND AVERAGE CAPITAL OF PLANTATION LOGGING EQUIPMENT

	Light grader	Crawler tractor	Snig tractor	Chainsaw	Log ** truck	Hydraulic ** loader
Delivered cost PNG	55,856	76,296	12,925	500*	26,017	8,000*
Salvage value	10,800	15,200	2,600	50		
Years of working life	6	5	5	1		
Days operated per year	200	200	200	250		
Hours operated per day	7.5	7.5	7.5	4		
Annual depreciation	7,200	12,160	2,080	400		
Annual insurance	1,080	1,520	260	40		
Maintenance						
Fixed	2,880	4,864	832	-		
Variable	3,240	5,472	936	800		
Fuel, oil & lubricants/yr.	900	1,350	600	800		
Total operating cost per hr.	10.20	16.91	3.14	2.03		
Average capital value	32,400	45,600	7,800	275		

*. Personal estimate; ** Details shown in Table B.11

APPENDIX B (cont.)

TABLE B.10 DETAILS OF OWNING AND OPERATING COSTS OF A LOG TRUCK

Owning costs	Truck (K per Km)	Loader (K per hr)
Depreciation*	0.069	6.77
Insurance	0.006	0.64
Operating costs		
Fuel	0.100	2.35
Oil	0.007	0.16
Maintenance	0.069	3.24
Tyres	0.080	
Total own/operate costs excluding interest	0.33	13.16
Assumptions		
Salvage	5,200	1,600
Working life (km)	300,000	300,000
Days/yr. operated	250	250
Operation per day	320 km	1.1 hr
Diesel fuel-consumption	0.83 litre/km	50% fuel & oil consumption per hr of travelling
-cost	K0.12/litre	
Oil - consumption	0.017/litre	
- cost	K0.40/litre	
Maintenance	100% of depreciation	

* All truck depreciation charged to travelling
* Based on De Vries (1973)

APPENDIX B (cont.)

TABLE B.11 COMPARATIVE CHARACTERISTICS OF LOGGING SITUATIONS

	FAO Model No.1	FAO model No.2	Northern district
Forest	Tropical rainforest	Tropical rainforest	*E. deglupta* plantation
Logging operation	2 phase	2 phase	1 phase
Harvest (m^3/annum)	330,000	330,000	100,000 to 363,000
Logging unit harvest (m^3/annum)	50,000	50,000	
Veneer sawlog	67%	33%	-
Chiplog	33%	77%	100%
Total volume (m^3/ha)	80	160	250

Source: FAO models are from FAO (1974a)

APPENDIX B (cont.)

TABLE B.12 COSTS OF HARVESTING AND TRANSPORT OPERATIONS BY OPERATION AND EQUIPMENT CATEGORY

Operation / Vehicle or machine		Survey utility	Shortwood production	Snigging wheeled tractor	Transport truck	Load/unload self-mounted crane	Total
Year	12	-	-	-	-	-	-
	13	110	29,030	91,060	527,340	65,800	713,340
	14	110	29,030	91,060	527,340	65,800	713,340
	15	123	32,514	101,987	590,621	73,696	798,941
	16	123	32,514	101,987	590,621	73,696	798,941
	17	123	32,514	101,987	590,621	73,696	798,941
	18	134	35,127	110,183	638,081	79,618	863,143
	19	134	35,127	110,183	638,081	79,618	863,143
	20	134	35,127	110,183	638,081	79,618	863,143
	21	204	53,706	168,461	975,579	121,730	1,319,680
	22	204	53,706	168,461	975,579	121,730	1,319,680
	23	204	53,706	168,461	975,579	121,730	1,319,680
	24	204	53,706	168,461	975,579	121,730	1,319,680
	25	204	53,706	168,461	975,579	121,730	1,319,680
	26	328	86,220	270,448	1,566,200	195,426	2,118,622
	27	401	105,197	330,548	1,914,244	238,854	2,589,244
	28	401	105,197	330,548	1,914,244	238,854	2,589,244
	29	401	105,197	330,548	1,914,244	238,854	2,589,244
	30	401	105,197	330,548	1,914,244	238,854	2,589,244

APPENDIX B (cont.)

TABLE B.13 SALARIES AND WAGES OF LOGGING CREWS

Year	Supervisors and operator/drivers	Chainsaw* operators	Labourers
12	-	-	-
13	117208	18200	30004
14	117208	18200	30004
15	132309	20384	33605
16	132309	20384	33605
17	132309	20384	33605
18	141690	22022	36304
19	141690	22022	36304
20	141690	22022	36304
21	218785	33670	55507
22	218785	33670	55507
23	218785	33670	55507
24	218785	33670	55507
25	218785	33670	55507
26	351094	54054	89112
27	430279	66066	109148
28	430279	66066	109148
29	430279	66066	109148
30	430279	66066	109148

* This item also includes the wages of labourers attached to the chainsaw operators

APPENDIX B (cont.)

TABLE B.14 AVERAGE CAPITAL INVESTED IN THE PLANTATION HARVESTING AND TRANSPORT OPERATION

Year	Average invested capital			Conting- encies	Av.capital
	Road construction/ maintenance	Survey & log transport	Fixed assets & overhead equipment		
12	-	-	-	-	-
13	18,711	258,261	53,781	28,702	197,105
14	18,711	258,261	53,781	28,702	197,105
15	18,711	288,357	60,285	32,037	217,927
16	18,711	288,357	60,285	32,037	217,927
17	18,711	288,357	60,285	32,037	217,927
18	18,711	310,540	65,070	34,496	236,989
19	18,711	310,540	65,070	34,496	236,989
20	35,810	317,380	65,070	35,345	236,989
21	34,984	477,970	99,589	53,126	363,915
22	29,670	477,970	99,589	53,126	363,915
23	29,670	477,970	99,589	53,126	363,915
24	29,670	477,970	99,589	53,126	363,915
25	46,769	482,684	99,589	53,126	363.915
26	43,385	762,242	159,874	84,653	581,959
27	43,485	927,761	195,446	102,983	709,785
28	43,485	927,761	195,446	102,983	709,785
29	43,485	927,761	195,446	102,983	709,785
30	43,485	927,761	195,446	102,983	709,785

APPENDIX B (cont.)

The estimated average capital invested in logging and transport equipment shown in Table B.15 was obtained directly from the estimates of the plant engaged (see Table 8.9), and the average capital of each of these items (see Table B.10).

The estimated average capital invested in fixed assets was obtained indirectly. The capital costs of overhead assets in the two logging models (see Table B.12) were calculated as a percentage of direct costs. The percentage calculated was 5% in both cases. Thus the estimated average fixed capital invested in overheads in the plantation project is 5% of direct logging costs.

The average capital invested in road construction was based on the average capital invested in the major equipment engaged. A ratio of average invested capital and owning and operating costs was obtained for each of these items of equipment (see Table B.16). These ratios were then converted to a percentage. These percentages were combined to provide a weighted average. The average fixed capital invested in roading equipment was estimated to be 105% of the total direct costs, on the basis that 70% of costs of roading operations are equipment costs (FAO, 1974a). The estimate for working capital is equal to two months total direct operating costs, which was the basis used by FAO (1966). The provision for contingencies is 5% of the average capital invested in the other items.

APPENDIX B (cont.)

TABLE B.15 AVERAGE CAPITAL OF MAJOR CAPITAL ITEMS USED IN ROAD MAKING

	Average capital*	Average capital as % age of owning & operating costs
Crawler tractor **	45,600	180
Grader	32,400	212
Utility	1,620	117
Truck	15,600	50

* Average capital from Table B.10

** Plant specifications are shown in Table A.4

APPENDIX C

APPENDIX C (cont.)

TABLE C.1 OWNING AND OPERATING COSTS, AND AVERAGE CAPITAL, OF PLANTATION PROJECT AND EQUIPMENT

	Station sedan	Utility	Motor cycle	Water tanker	Plough	Agricultural tractor	Plant carrier
Delivered price P.N.G. *	5,662	2,718	743	21,464	2,500	3,500	400
Salvage values	1,120	540	140	4,200	500	700	400
Years of working life	4	4	3	10	8	4	10
Days operated per year	250	250	250	40	50	200	60
Hours operated per day	3	3	3	2	7.5	3	7.5
Annual depreciation	1,136	545	201	1,726	250	700	110
Annual repairs & maintenance							
Fixed	440	216	74	672	100	280	80
Variable	252	122	42	51		126	
Fuel, oil & lubricants	525	450	225	40	-	180	-
Total owning & operating costs	3.26	1.84	0.72	35.79	1.07	2.26	0.62
Average capital value	3,391	1,629	441	12,832	1,500	2,100	950

* See Table C.2

TABLE C.2 DELIVERED PRICE OF PLANTATION PROJECT VEHICLES AND EQUIPMENT

	Station sedan	Utility	Motor cycle	Water tanker	Plough	Agricultural tractor	Plant carrier
				($A)			
Cost in Australia *	8,000	3,800	670	33,000	-	-	-
Sales tax (%)	27.5	15	15	15			
Australian import duty (%)	25	25	-	22.5	-	-	-
Residual	4,350	2,423	570	21,739	-	-	-
				(kina)			
Residual	3,828	2,132	520	19,130	-	-	-
Import duty PNG (%)	45	25	45	10	-	-	-
Cost of delivery PNG (%)	2	2	2	2	-	-	-
Delivered price P.N.G.	5,662	2,718	743	21,464	2,500	3,500	1,500

* Based on enquiries at dealers

APPENDIX C (cont.)

TABLE C.3 COMPONENTS OF HIRE RATE FOR HEAVY EQUIPMENT

	Crawler tractor * (kina per hour)	Grader (kina per hour)
Operating cost	16.91	10.20
Interest on average capital (13%)	3.95	2.81
Operator cost (K 2600 per 2000 hrs)	1.30	1.30
Transport charges (K 1000 per 1500 hrs)	0.66	-
Estimated hire rate	22.82	14.31

* Specification shown in Table A.4

APPENDIX C (cont.)

TABLE C.4 INITIAL CAPITAL OUTLAYS AND OTHER COSTS OF PLANTATION PROJECT VEHICLES AND EQUIPMENT
(Kina)

Year	Initial capital outlays*	Depreciation	Insurance	Repairs & maintenance	Petrol oil lubricants
1	-	-	-	-	-
2	-	-	-	-	-
3	21200	4128	424	2508	2625
4	-	4128	424	2508	2625
5	21000	5808	844	3231	2665
6	-	5808	844	3231	2665
7	-	5808	844	3231	2665
8	-	5808	844	3231	2665
9	-	5808	844	3231	2665
10	-	5808	844	3231	2665
11	6900	8160	1094	4641	3820
12	-	8160	1094	4641	3820
13	-	8160	1094	4641	3820
14	-	8160	1094	4641	3820
15	-	8160	1094	4641	3820
16 **	-	8532	1122	4873	4270

*. These outlays do not include vehicle replacement

** Beyond year 16 annual costs remain unchanged

APPENDIX C (cont.)

TABLE C.5 OWNING AND MAINTENANCE COSTS OF PLANTATION PROJECT BUILDINGS (kina)

	Tubing complex	Fire tower	Office aid complex	House Std.1	House Std.2
Construction cost	40000	2600	20000	13000	5200
Salvage value (1)	4000	260	2000	1300	520
Life(years) (2)	-	-	-	10	10
Annual depreciation (3)	2769	180	1385	1170	468
Annual insurance (4)	230	14	110	71	29
Annual repairs & maintenance (5)	2000	130	1000	650	260
Average capital value	23000	1400	11000	7150	2860

Notes on Table C.5

(1) Salvage value is estimated to be 10% of construction cost.

(2) Only houses are replaced. Other structures are progressively updated

(3) Personal estimates.

(4) 1% of average value.

(5) 5% construction cost.

APPENDIX C (cont.)

TABLE C.6 INITIAL CAPITAL OUTLAYS AND OTHER COSTS OF PLANTATION PROJECT BUILDINGS (Kina)

Year	Initial capital outlays*	Depreciation	Insurance	Repairs & maintenance
1	-	-	-	-
2	-	-	-	-
3	110200	11189	717	6510
4	-	12430	788	7160
5	5200	11880	760	6900
6	-	11880	760	6900
7	-	11880	760	6900
8	-	13121	831	7550
9	-	11880	760	6900
10	-	11880	760	6900
11	15600	13371	874	8330
12	-	13371	874	8330
13	2600	13565	861	8460
14	-	13565	861	8460
15	-	13565	861	8460
16	15600	15056	948	9240
17	-	15056	948	9240
18**	2600	15250	962	9370

* These outlays do not include building replacement

** Beyond year 18 annual costs remain unchanged

APPENDIX C (cont.)

TABLE C.7 INITIAL CAPITAL OUTLAYS AND OTHER COSTS OF PLANTATION PROJECT OFFICE EQUIPMENT AND FURNITURE (Kina)

Year	Initial capital Outlays		Depreciation		Repairs & maintenance
	F	OE	F	OE	
1	-	-	-	-	-
2	-	-	-	-	-
3	1600	650	70	30	-
4	-	-	70	30	-
5			70	30	
6			70	30	260
7			70	30	260
8			70	30	260
9			70	30	260
10			70	30	260
11			70	30	260
12			70	30	260
13			70	30	260
14			70	30	260
15			70	30	260
16	600	540	140	60	400
17*		540	140	60	400

F = furniture OE = office equipment

* Beyond year 17 annual costs remain unchanged

APPENDIX C (cont.)

TABLE C.8 INITIAL CAPITAL OUTLAYS AND OTHER COSTS OF PLANTATION PROJECT COMMUNICATION EQUIPMENT (Kina)

Year	Initial capital outlays*	Depreciation	Insurance	Repairs and maintenance
1				
2				
3				
4				
5	13000	600	130	-
6		600	130	670
7		600	130	670
8		600	130	670
9		600	130	670
10		600	130	670
11		600	130	670
12		600	130	670
13	1500	675	150	670
14		675	150	850
15		675	150	850
16		675	150	850
17		675	150	850
18	1500	750	160	850
19		750	160	850
20		750	160	850
21**		750	160	1140

* These outlays do not include replacements

** Beyond year 21 annual costs remain unchanged

APPENDIX C (cont.)

TABLE C.9 COST OF PLANTATION PROJECT SUPPLIES (kina)

(a) Plantation supplies

Year	Culvert (1)	*Styloanthus* seed (2)	Poison (3)	Tools & equipment	
				Establish.	Protection
1					
2					
3	200	720		1000	400
4	200	720		800	400
5	250	806		800	800
6	250	806		800	800
7	250	806		800	800
8	250	871		800	800
9	250	871		800	800
10	250	871		800	800
11	250	1332	100	1200	800
12	250	1332	100	1200	800
13	250	1332	100	1200	800
14	150	1332	100	1200	800
15	50	1332	100	1200	800
16	50	2138	274	1500	800
17	50	2614	377	2400	800
18	50	2614	377	2400	1000
19	-	2614	377	2400	1000
20		2614	377	2400	1000
21		2614	377	2400	1000
22		2614	278	2400	1000
23		2614	278	2400	1000
24		2614	278	2400	1000
25		2614	278	2400	1000
26		2614	278	2400	1000
27		2614	86	2400	1000
28*		2614	-	2400	1000

* Beyond year 28 annual costs remain unchanged

APPENDIX C (cont.)

TABLE C.9 (cont.)

(b) Other supplies (kina)

Year	Plant productn. (thous.)	Tubing soil (4)	Fertilizer (5)	Plastic tubes (6)	Tools	Office supplies	Petrol, oil lubricants
1							
2							
3	(351)	913	35	597	1000		2625
4	(351)	913	35	597	200		2625
5	(393)	1022	39	668	200		2665
6	(393)	1022	39	668	200	130	2665
7	(393)	1022	39	668	200	130	2665
8	(425)	1105	43	723	200	130	2665
9	(425)	1105	43	723	200	130	2665
10	(425)	1105	43	723	200	130	2665
11	(649)	1687	65	1103	200	130	3820
12	(649)	1687	65	1103	200	130	3820
13	(649)	1687	65	1103	200	130	3820
14	(649)	1687	65	1103	200	130	3820
15	(649)	1687	65	1103	200	130	3820
16	(1042)	2709	104	1771	200	260	4270
17*	(1274)	3312	127	2166	200	260	4270

* Beyond year 17 annual costs remain unchanged.

Notes on estimates in Table C.9

(1) Culvert K10 per m

(2) Legume seed K 0.30 per kg
1.80 kg per ha

(3) Poison K 0.4 per ha

(4) Tubing soil K 2.6 per thousand plants produced

(5) Fertilizer K 0.1 per thousand

(6) Plastic tubes K 1.3 per thousand

Based on White (1974) and personal experience

APPENDIX C (cont.)

TABLE C.10 AVERAGE INVESTED CAPITAL OF THE PLANTATION PROJECT (kina)

Year	Buildings	Vehicles & plant	Communication equipment	Furniture	Office equipment
1					
2					
3	71610	12720	7500	900	350
4	78760	12720	7500	900	350
5	75900	12720	7500	900	350
6	75900	25320	7500	900	350
7	75900	25320	7500	900	350
8	83050	25320	7500	900	350
9	75900	25320	7500	900	350
10	75900	25320	7500	900	350
11	84480	32820	7500	900	350
12	84480	32820	7500	900	350
13	85910	32820	8350	900	350
14	85910	32820	8350	900	350
15	85910	32820	8350	900	350
16	94490	33660	8350	1600	650
17	94490	33660	8350	1600	650
18*	95920	33660	9200	1600	650

* Beyond year 18 there is no change in the level of average capital

APPENDIX C (cont.)

TABLE C.11 CALCULATION OF PRESENT NET WORTH

Year	(V_t)	$((1 + i)^{t-3})$	(V_3) positive	(V_3) negative
1				
2				
3	141,441	1		141,441
4	168,526	1.1		153,205
5	162,779	1.21		134,528
6	168,471	1.331		126,575
7	168,572	1.464 1		115,137
8	183,092	1.610 5		113,686
9	163,761	1.771 561		92,429
10	163,898	1.948 717		84,106
11	217,204	2.143 589		101,327
12	251,872	2.357 948		106,818
13	+11,972	2.593 742	4,616	-
14	+ 9,768	2.853 117	3,424	
15	-40,424	3.138 428	12,880	
16	-61,531	3.452 271	-	17,823
17	-103,062	3.797 498		27,139
18	-107,054	4.177 248		25,628
19	-107,093	4.594 973		23,307
20	-128,262	5.054 470		25,376
21	+32,094	5.559 917	5,772	-
22	+54,193	6.115 909	8,861	
23	+60,579	6.727 500	9,005	
24	+59,404	7.400 250	8,027	
25	+40,691	8.140 275	4,999	
26	+328,286	8.954 302	36,662	
27	+527,577	9.849 733	53,563	
28	+553,892	10.834 706	51,122	
29	+5,565,690	11.918 177	470,348	
Totals			669,279	1,288,527
		Balance (-)	K 619,248	

Table C.11 shows the annual balances of the plantation project (V_t); the discount factors to year 3 ($(1+i)^{t-3}$) using i = 0.01 the net worths in year 3 of the balances; and the sumes of these balances. The annual balances beyond year 29 are shown by a capitalized value in year 29.

APPENDIX D

APPENDIX D (cont.)

TABLE D.1 UNSKILLED LABOUR COSTS OF PLANTATION PROJECT (Kina)

Year	Direct financial cost - wages	Total* financial cost	Social cost
1			
2			
3	10,036	11,040	3,864
4	16,276	17,904	7,341
5	17,238	18,962	8,912
6	17,989	19,788	10,290
7	17,989	19,788	11,477
8	19,295	21,225	13,584
9	19,856	21,842	15,289
10	19,856	21,842	16,600
11	34,216	37,638	30,863
12	43,571	47,928	42,177
13	43,571	47,928	45,052
14	42,635	46,899	46,899
15	42,635	46,899	49,713
16	67,930	74,723	83,690
17	99,005	108,906	128,003
18	108,615	119,477	148,151
19	107.920	118,712	153,901
20	108,532	119,385	163,557
21	108,532	119,385	170,721
22	99,679	109,647	163,374
23	94,354	103,789	160,873
24	94,354	103,789	167,100
25	94,354	103,789	173,328
26	94,354	103,789	179,555
27	77,342	85,076	152,286
28	59,501	65,451	121,084
29**	54,925	60,418	114.794

* Total financial cost includes 10% loading to cover holiday and sick pay

** Beyond year 29 annual costs remain the same

APPENDIX D (cont.)

TABLE D.2 STAFF COSTS (Kina)

Year	Direct financial cost - salaries	Total** financial cost	Social cost
1			
2			
3	24,484	26,932	24,508
4	40,585	44,644	41,072
5	42,786	47,065	43,300
6	42,831	47,114	43,816
7	43,264	47,590	44,735
8	51,632	56,795	53,387
9	50,644	55,708	52,923
10	50,651	55,716	53,487
11	55,340	60,874	58,439
12	55,352	60,887	59,060
13	67,996	74,796	72,552
14	68,381	75,219	73,715
15	68,386	75,225	74,473
16	96,016	105,618	104,562
17	97,185	106,904	106,904
18	97,173	106,890	107,959
19	97,217	106,939	108,008
20	97,231	106,954	109,093
21	97,499	107,249	109,394
22	97,091	106,800	110,004
23	97,102	106,812	110,084
24	97,111	106,822	111,095
25	97,122	106,834	112,176
26	97,129	106,842	113,253
27***	96,328	105,961	112,319

* Excludes expatriate staff costs

** Total financial cost includes 10% loading to cover holiday & sick pay

*** Beyond year 27 annual costs remain the same

APPENDIX D (cont.)

TABLE D.3 EXPATRIATE STAFF COSTS (Kina)

Year	Direct financial cost - salaries	Total* financial cost	Social cost
1			
2			
3	46,800	51,480	51,480
4	46,800	51,480	51,480
5	36,400	40,040	40,040
6	36,400	40,040	40,040
7	36,400	40,040	40,040
8	36,400	40,040	40,040
9	20,800	22,880	22,880
10	20,800	22,880	22,880
11	20,800	22,880	22,800
12	20,800	22,880	22,880

* Total financial cost includes 10% loading to cover holiday, sick pay, and other benefits

APPENDIX D (cont.)

TABLE D.4 PERCENTAGE OF ANNUAL PLANTINGS ESTABLISHED ON NEW SITES

Year	%	Year	%
1		15	46
2	-	16	62
3	100	17	69
4	100	18	69
5	100	19	67
6	100	20	67
7	100	21	67
8	100	22	49
9	100	23	49
10	100	24	49
11	100	25	49
12	100	26	49
13	100	27	15
14	46	28	-

Basis of estimate of the proportion of labour costs in buildings

Two carpenters plus two assistants can built a Standard 2 house in one month. McCarthy (pers. comm., 1976-)

Construction cost Std. 2 house K 5200
Salaries of workers

2x2600/12 = 433
2x1560/12 = 260 K 693

$$\frac{693 \times 100}{5200} = 13\%$$

13% is adopted as the proportion of labour costs in all plantation project building construction.

APPENDIX D (cont.)

TABLE D5 SOCIAL COST OF MATERIAL RESOURCES USED IN THE PLANTATION PROJECT

Year	Building construction	Vehicles & plant owned & operated	Plant hire	Maintenance blgs,vehicles furniture, plant & equip.	Office equip.	furnit-ure	Communic-ation equipment	Supplies	Contin-gencies	Total costs
1										
2										
3	10358	4552	11696	4509	30	70	-	7490	3869	42567
4	11500	4552	11795	4834	30	70	-	7490	4027	44298
5	10997	6652	13276	5066	30	70	730	5000	4182	46003
6	10997	6652	13809	5530	30	70	730	7380	4519	49718
7	10997	6652	13468	5531	30	70	730	7380	4485	49344
8	12138	6652	14426	5856	30	70	730	7587	4748	52238
9	10997	6652	14740	5030	30	70	730	7587	4583	50420
10	10997	6652	14857	5030	30	70	730	7587	4595	50548
11	12393	9254	32562	6950	30	70	730	11687	7367	81044
12	12393	9254	32737	6950	30	70	730	11687	7385	81236
13	23494	9254	34945	6950	30	70	825	11687	7615	83769
14	12393	9254	38547	7106	30	70	825	10487	7871	86583
15	12393	9254	38611	7106	30	70	825	10487	7877	86654
16	13922	9654	70229	7681	60	140	825	14136	11664	128312
17	13922	9654	88531	7682	60	140	825	11348	13216	145378
18	14104	9654	88724	7632	60	140	910	16776	13800	151800
19	14104	9654	88724	7632	60	140	910	16726	13863	152500
20	14104	9654	89625	7891	60	140	910	16726	13911	153021
21	14104	9654	89775	7891	60	140	910	16726	13926	153186
22	14104	9654	83383	7891	60	140	910	16726	13286	146155
23	14104	9654	83546	7891	60	140	910	16726	13303	146334
24	14104	9654	83696	7891	60	140	910	16726	13318	146499
25	14104	9654	83859	7891	60	140	910	16726	13334	146678
26	14104	9654	83966	7891	60	140	910	16726	13263	145894
27	14104	9654	71428	7891	60	140	910	16435	12062	132684
28	14104	9654	65798	7891	60	140	910	16343	11490	126390
29	14104	9654	65798	7891	60	140	910	14849	11340	124747

APPENDIX D (cont.)

Table D.5 shows the social cost of the material resources used in the plantation project. Insurance and contingencies of 10% are included as crude estimates of unforseen material inputs. Plant hire excludes the cost of a driver/operator but does include all maintenance costs. As some labour would be included this item is slightly inflated. The estimate for maintenance of buildings, vehicles and plant owned, furniture, and radio equipment does not include labour. Estimates for capital items do not include interest.

APPENDIX D (cont.)

TABLE D.6 CALCULATION OF SOCIAL VALUE AND SOCIAL NET WORTH IN YEAR 3

Year	Annual surplus	Social value Annual surplus	Annual deficit	Social value Annual deficit	$(1+i)^{t-3}$*	Social value in year 3 Surplus	Social value in year 3 Deficit
1							
2							
3			122,419	394,189	1		394,189
4			144,191	457,085	1.05		406,748
5			138,255	431,356	1.102 5		391,253
6			143,864	461,662	1.157 625		398,801
7			145,596	439,700	1.215 506		361,742
8			159,249	472,970	1.276 282		370,580
9			141,512	413,215	1.340 096		308,347
10			143,512	411,879	1.407 100		292,715
11			193,226	544,897	1.477 455		368,808
12			228,320	632,446	1.551 328		407,680
13	31,113	31,113	-	-	1.628 895	19,101	-
14	25,289	25,289	-	-	1.710 339	14,786	-
15	52,378	52,378	-	-	1.795 856	29,166	-
16	-	-	54,731	187,727	1.885 649	-	99,556
17	-	-	107,452	351,368	1.979 931		177,465
18			121,615	389,168	3.029 932		128,441
19			128,114	399,716	3.181 428		125,640
20			159,676	485,415	3.340 500		145,312
21			6,312	18,747	3.507 525		5,345
22	13,056	13,056	-	-	3.682 901	3,545	-
23	15,298	15,298	-	-	3.867 046	3,956	-
24	7,895	7,895	-	-	4.060 398	1,944	-
25	-	-	19,115	56,198	4.263 418	-	13,181
26	262,086	262,086	-	-	4.476 589	58,546	-
27	469,084	469,084			4.700 418	99,796	-
28	506,580	506,580			4.935 439	102,641	-
29	514,513	514,513			5.182 211	992,845*	

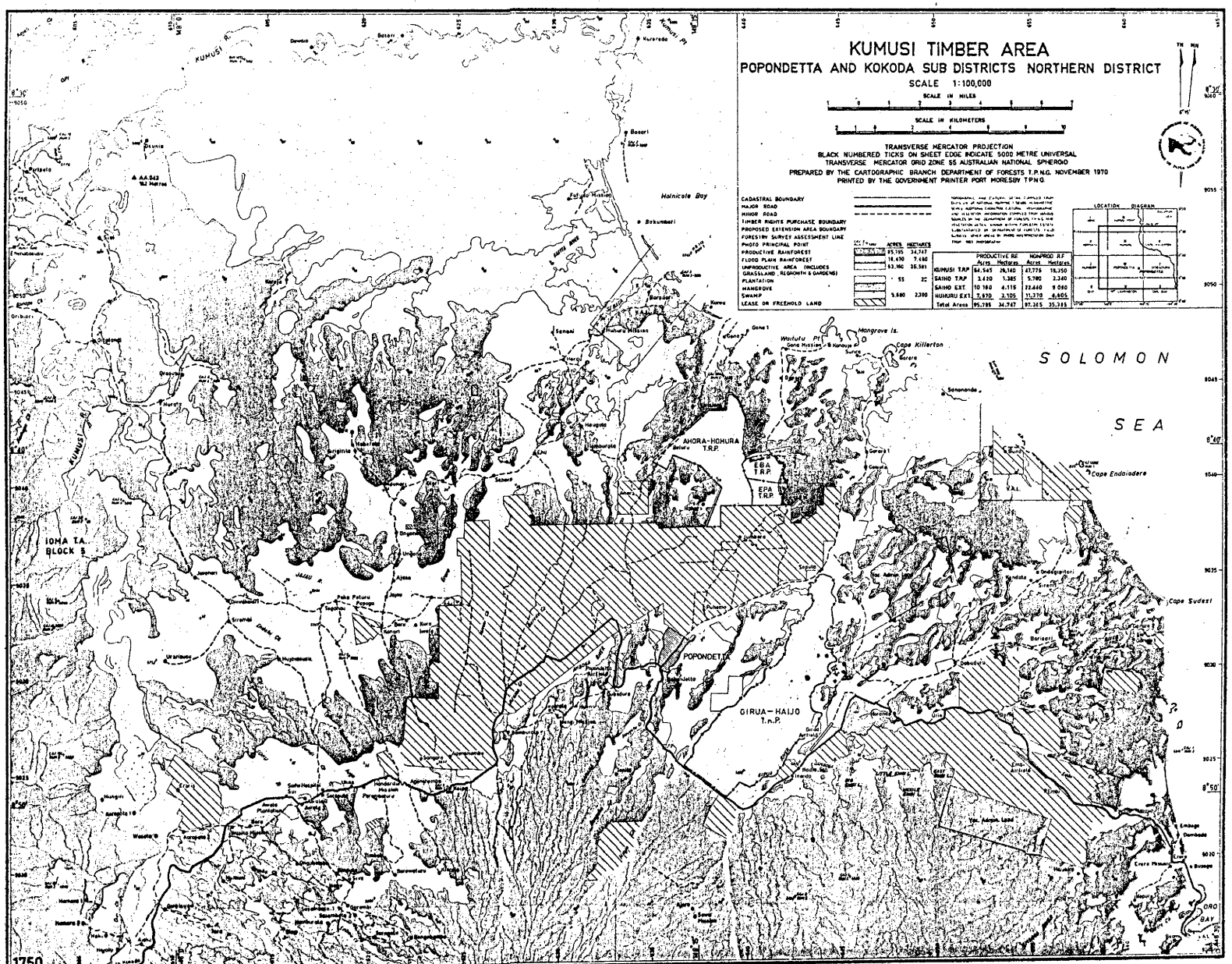
* Annual surplus capitalized value of stream of i is 0.05

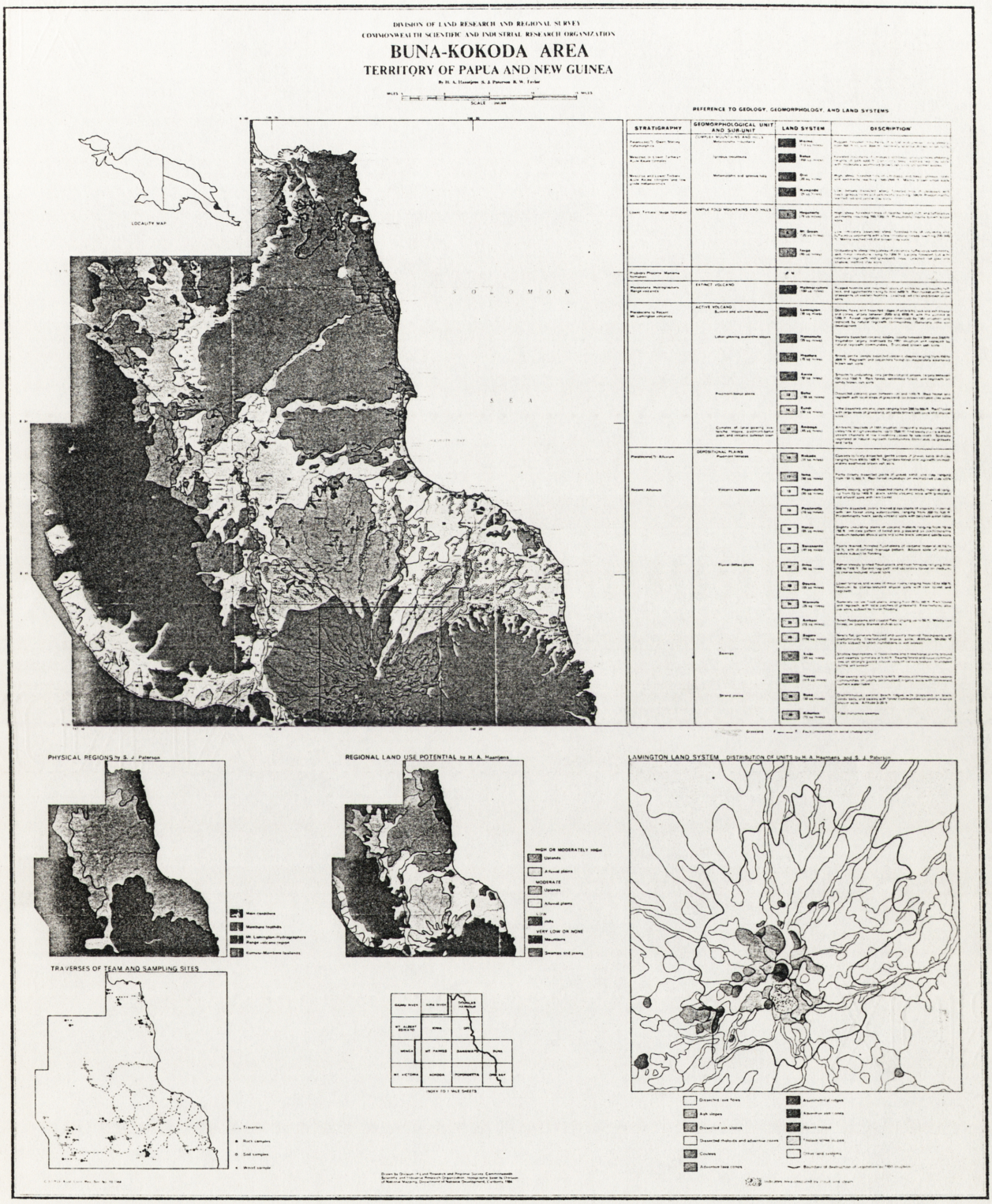
APPENDIX D (cont.)

Table D.6 shows the calculation of the estimated net social worth of the plantation project in year 3. Annual capital surpluses and deficits are adjusted to social values using shadow prices from Table 10.3. Annual balances beyond year 29 are the same, and these are first capitalized to year 29. Then all the social balances are discounted to year 3 using a discount rate of 0.05 and the appropriate factor. The social net worth is the balance of the sum of these discounted balances.

		Kina
Social net worth of all annual surpluses in year 3		1,326,326
Social net worth of all annual deficits in year 3		4,395,803
Social net worth of the plantation project in year 3	(-)	3,069,477

APPENDIX E


KUMUSI TIMBER AREA
POPONDETTA AND KOKODA SUB DISTRICTS NORTHERN DISTRICT
SCALE 1:100,000
SCALE IN MILES
SCALE IN KILOMETERS
TRANSVERSE MERCATOR PROJECTION
BLACK NUMBERED TICKS ON SHEET EDGE INDICATE 5000 METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 55 AUSTRALIAN NATIONAL SPHEROID
PREPARED BY THE CARTOGRAPHIC BRANCH DEPARTMENT OF FORESTS T.P.N.G. NOVEMBER 1970
PRINTED BY THE GOVERNMENT PRINTER PORT MORESBY TPNG
CADASTRAL BOUNDARY
MAJOR ROAD
MINOR ROAD
TIMBER RIGHTS PURCHASE BOUNDARY
PROPOSED EXTENSION AREA BOUNDARY
FORESTRY SURVEY ASSESSMENT LINE
PHOTO PRINCIPAL POINT
PRODUCTIVE RAINFOREST
FLOOD PLAIN RAINFOREST
UNPRODUCTIVE AREA (INCLUDES GRASSLAND, REGROWTH & GARDENS)
PLANTATION
MANGROVE
SWAMP
LEASE OR FREEHOLD LAND
ACRES HECTARES
85,795 34,747
18,490 7,486
83,160 33,581
55 22
5,840 2,300
LOCATION DIAGRAM
PRODUCTIVE RF NONPROD R.F.
As/Is Hectares Acres Hectares
KUMUSI T.R.P. 64,545 26,140 43,775 18,350
SAIHO T.R.P. 3,420 1,385 5,780 2,340
SAIHO EXT. 10,160 4,115 22,440 9,090
KUHURU EXT. 7,670 3,105 31,370 6,805
Total Areas 95,795 34,747 97,365 35,385
Honiara Bay
Bokumbari
Kuhuru Mission
Mongrove Is.
Cape Killerton
SOLOMON
SEA
Cape Endoiadere
Cape Sudest
AHORA-HOHURA T.R.P.
EBA T.R.P.
EPA T.R.P.
IOMA T.A. BLOCK 5
POPONDETTA
GIRUA-HAIJO T.n.P.
ORO BAY
1750


DIVISION OF LAND RESEARCH AND REGIONAL SURVEY
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
BUNA-KOKODA AREA
TERRITORY OF PAPUA AND NEW GUINEA
By H. A. Haantjens, S. J. Paterson & R. W. Taylor
SCALE
LOCALITY MAP
SOLOMON
SEA
PREFERENCE TO GEOLOGY, GEOMORPHOLOGY, AND LAND SYSTEMS
STRATIGRAPHY
GEOMORPHOLOGICAL UNIT AND SUB-UNIT
LAND SYSTEM
DESCRIPTION
COMPLEX MOUNTAINS AND HILLS
SIMPLE FOLD MOUNTAINS AND HILLS
EXTINCT VOLCANO
ACTIVE VOLCANO
DEPOSITIONAL PLAINS
Piedmont terraces
Volcanic outwash plains
Fluvial deltaic plains
Swamps
Strand plains
Mountains
Hills
Plateaux
Volcanoes
Alluvial plains
Swamps and plains
Grassland
Fault, intermittent or partly concealed
PHYSICAL REGIONS by S. J. Paterson
Main mainland
Moresby foothills
Mt. Lamington-Hydrographers Range volcanic region
Kumusi-Mambare lowlands
REGIONAL LAND USE POTENTIAL by H. A. Haantjens
HIGH OR MODERATELY HIGH
Uplands
Alluvial plains
MODERATE
Uplands
Alluvial plains
LOW
Hills
VERY LOW OR NONE
Mountains
Swamps and plains
LAMINGTON LAND SYSTEM DISTRIBUTION OF UNITS by H. A. Haantjens and S. J. Paterson
Dissected axe faces
Rift ridges
Dissected rift slopes
Dissected footslopes and adventive cones
Craters
Adventive lava cones
Accumulating ridges
Adventive axe cones
Recent mudflow
Mudflow scree slopes
Other land systems
TRAVERSES OF TEAM AND SAMPLING SITES
Traverses
Rock samples
Soil samples
Wood samples
INDEX TO 1 MILE SHEETS
GAIRO RIVER
KAPA KAPA
MT. ALBERT EDWARD
KOKODA
MT. FAIRFAX
DAWSON
MT. VICTORIA
KOKODA
PORORANTA
ORO BAY

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